AD-787 059

AEROMECHANICAL ANALYSIS OF A TOW TARGET SYSTEM INSTALLED ON THE A-4 AIRPLANE

D. W. Carroll

Naval Air Development Center
Warminster, Pennsylvania

4 September 1974

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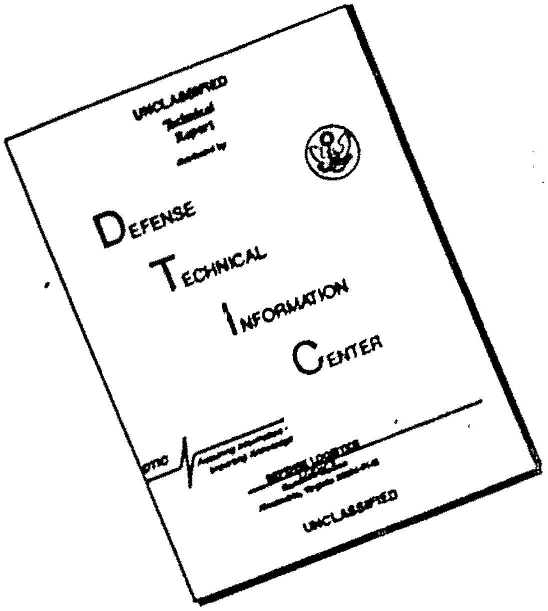

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The tow target system installation, analyzed in this report is intended for towing large towed targets for air-to-air and surface-to-air weapon training firing exercises. The system will also provide for the towing of smaller towed targets at towline lengths exceeding 6 miles. The analysis indicates that the installation is adequate, structurally, for target towing missions which are within the capability of the A-4 airplane. Flight test of the system is recommended to determine suitability for service use.

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S U M M A R Y

This report provides the results of an aeromechanical analysis of the flight worthiness of a tow target system installation for the A-4 airplane.

The tow target system consists of a modified RMU-8/A reel-launcher installed on the centerline Aero 7A bomb rack, controlled by a panel mounted in the left hand console in the cockpit (forward cockpit of "T" models of the A-4), 0.182 inch-diameter 3 x 7 cable towline (10,800 feet stored on the reel-launcher spool) and a large profile fighter tow target such as the "FIGAT". This system configuration, which is analyzed herein is considered the "worst case" among configurations which would include long towlines, air-launched and other drag launched towed targets and the new RMK-19/A47U-3 reel-launcher.

The system installation is structurally sensitive to yaw and to side load factor; however, the installation is considered adequate for target towing missions which are within the capability of the A-4 airplane. Mission capability is dependent upon the installed engine.

A-4s with J65-W-20 or J52-P-6 engines will be limited to towing maneuvers less than 2G. A-4s with the J52-P-8 or higher thrust engines can provide towing maneuvers to 3G. These limitations are imposed as a result of target tracking and towline geometry characteristics during low airspeed, high G turns and do not reflect a structural problem.

The following recommendations are advanced:

1. Due to yaw and side load sensitivity, it is recommended that rolling pullouts, abrupt control displacement and yawed flight be prohibited.

2. It is recommended that flight test of the system be conducted with the guidance provided in this report, to determine suitability for service use.

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INTRODUCTION

Under reference (a) the NAVAIRDEVCEN was tasked to develop a prototype large diameter power unit and a semi-automatic control system for the RMU-8/A reel-launcher. This development was successfully completed and tested on A-4 and F-4 airplanes as reported in reference (b).

The analysis generated for the purpose of prototype tests on the A-4 was not, however, adequate to justify tests for service suitability. This report provides the analysis considered necessary to justify service suitability tests.

DISCUSSION

The tow target system installation, as shown in figure 1, consists of a RMU-8/A (modified with a 30 inch diameter power unit and semi-automatic control system) installed on the centerline Aero 7A bomb rack of the A-4 airplane. A control panel is installed in the left hand cockpit console (forward cockpit of "T" models of the A-4). The reel-launcher spool is loaded with 10,800 feet of 0.182 inch-diameter 3 x 7 cable towline which is used to tow a large drag launched target such as the "FIGAT". Very long stepped diameter towlines may be loaded in the reel-launcher spool for operation with air launched targets which provide sufficient ground clearance for take-off and landing.

The analysis which was performed is provided in Appendix A. Supporting investigation and analysis of the Aero 7A centerline rack is provided in Appendix B and an analysis of the bolt reactions at the rack-airplane interface is provided in Appendix C.

The flight worthiness of the system is constrained by A-4 engine performance, the sway brace strength of the Aero 7A rack and the airplane structure supporting the store suspension system.

For a tow target mission with the "FIGAT", excess thrust of 2,000-3,000 pounds is required with wing tanks and the reel-launcher installed. The availability of excess thrust must coincide with a minimum airspeed required to maintain target and towline tracking in a maneuver. In addition, clearance between the towline and the reel-launcher pod surfaces must be maintained. These tracking and geometry requirements are exclusive of structural considerations.

High sway brace loads result from airplane yaw and side load factor due to rolling pull-out maneuvers. For the Aero 7A rack, the store yaw angle also increases with yawing moment due to yaw shift of the store in the suspension hooks. For the reel-launcher installation, the worst combination occurs when the reel-launcher spool is full and there is no target installed. Store weight, center of gravity position and center of pressure position maximize sway brace load for this case.

In view of the sensitivity to side load factor and yaw, restriction of the maneuverability of the airplane is considered appropriate. All applicable

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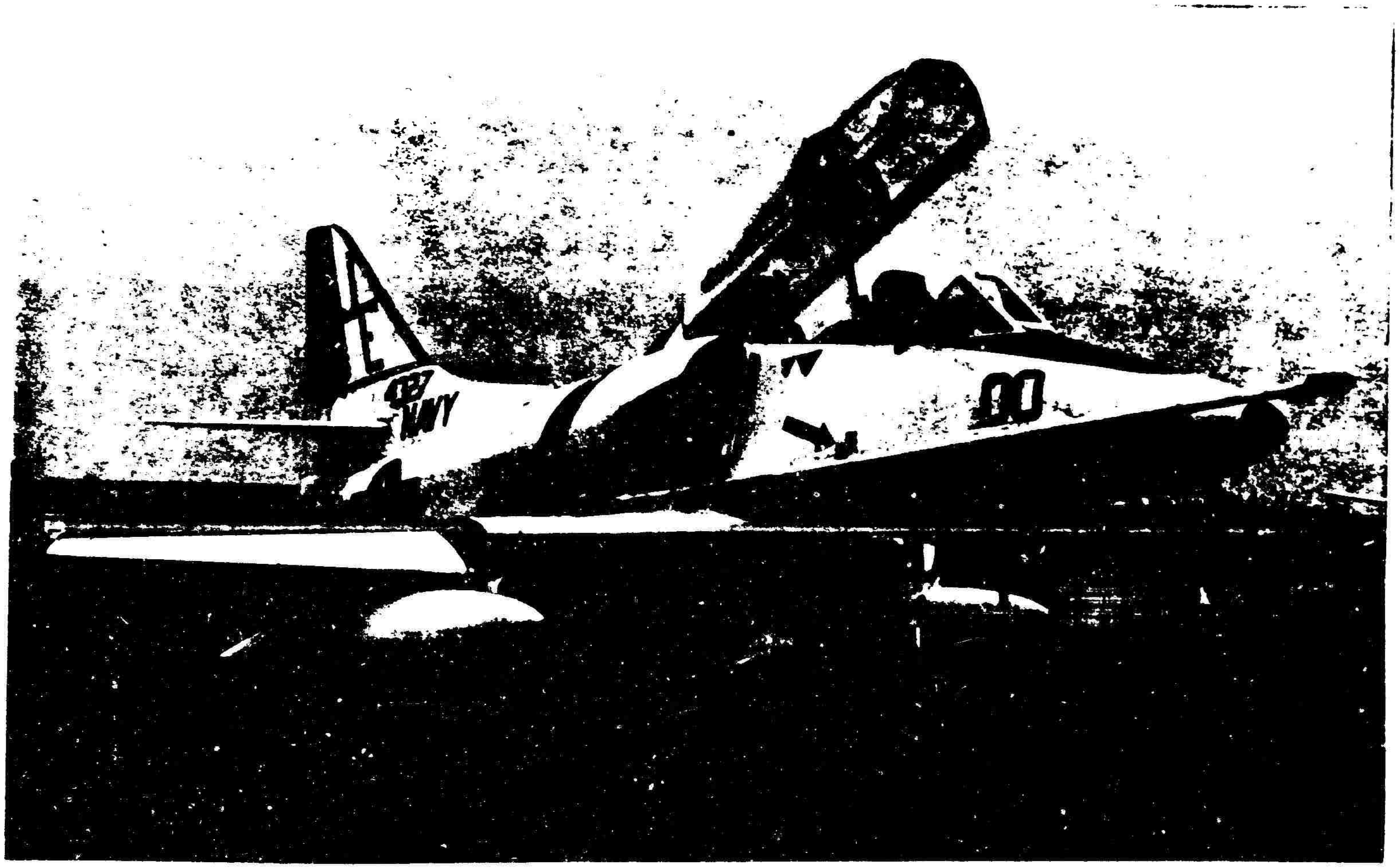

Figure 1. Modified RMU-8/A Installed on TA-4J Airplane.

recommended flight limitations and system rigging data are provided in Appendix D. Reel-launcher operating instructions are provided in reference (b). It is to be noted, however, that structural damage to the installation is unlikely even if these restrictions are not strictly adhered to; and, the restrictions do not constrain the tow target mission.

The analysis specifically addresses the towing of large drag launched targets. The configuration of the system can be readily altered for the launch, towing and recovery of towed targets which fit within the ground clearance envelope. The effect of this change on the analysis is to reduce sway brace reactions and bolt side loads due to the rearward shift of store center of gravity and center of pressure (target attached at reel-launcher tow point). Towing loads are also reduced due to the use of lower strength towline. Due to lower weight and a center of gravity position further aft, the RMK-19/A47U-3 reel-launcher would also produce lower loads on suspension components.

C O N C L U S I O N S

The tow target system analysis indicates that, although the system installation is sensitive to yaw and side load, the installation is adequate for towing large drag launched targets under take-off flight and landing conditions appropriate to shore based towing missions, including field arrestments.

Ferry flight limitations are common to all A-4s. Towing missions are limited by airplane engine performance. A-4s with J65-W-20 or J52-P-6 engines will be limited to towing maneuvers less than 2G. A-4s with the J52-P-8 or higher thrust engines can provide maneuvers to 3G. Towing restrictions result from target tracking and towline geometry characteristics.

It is recommended that flight test of the system installation be conducted within the recommended limits provided in Appendix D in order to determine suitability for service use.

REFERENCES

(a) AIRTASK A5355351-0014-4535000001.

(b) D. W. Carroll, R. Rohrman, F. X. Doyle, "Prototype Development of a Power Unit and Control System for a Towing Reel and Target Launcher," NADC Report No. NADC-73086-30, 2 Aug 1973.

A P P E N D I X A

TOW TARGET SYSTEM ANALYSIS

APPENDIX A

I. INTRODUCTION

This Appendix provides the detailed analysis performed to appraise the flight worthiness of a tow target system installed on the Navy A-4 airplane. The system consists of a modified RMU-8/A reel-launcher, 0.182 inch - diameter 3 x 7 steel cable towline and a large profile fighter type target such as the "FIGAT." The reel-launcher is installed on the centerline mounted AERO 7A bomb rack of the A-4.

The analysis examines the following aspects of the installation.

A A-4 Performance Data
B Profile Fighter Target (FIGAT) Data
C A-4 Performance Estimation
D. Towing Loads for Continuous Turns
E. Maneuvering Formulas (Appropriate for examination of loads and load factors in the airspace or on flight axes)
F. Reel-launcher Store Characteristics
G. Reel-Launcher Aero Loads
H. Suspension System (Under ferry flight, field arrestment and towing conditions)

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II ANALYSIS OF TARGET SYSTEM

A A-4 PERFORMANCE DATA

1. TOWING CONFIGURATION

2 300 GAL. WING TANKS
RMU-17/A37U-?, 6P RRR-L CAR OR RMU-8/A ON ℄

2. DATA SOURCE

USE NADC-73017-30 (A-4E) & NADC-73C72-30 (A-4C)
FOR EXCESS THRUST AVAILABLE A-4 WITH J52-P-6
& J65-W-20 ENGINES
ADD [illegible] LBS FOR J52-P-8 ENGINED A-4s

3. TEST DATA

NADC NA-4C CONFIGURED AS ABOVE FOR
TOWLINE TEST - TO GW = 21,700 LBS
MILITARY PWR { △ TENSION = 1200-1500 LBS.
MILITARY PWR { ○ TENSION = 900-1000 LBS

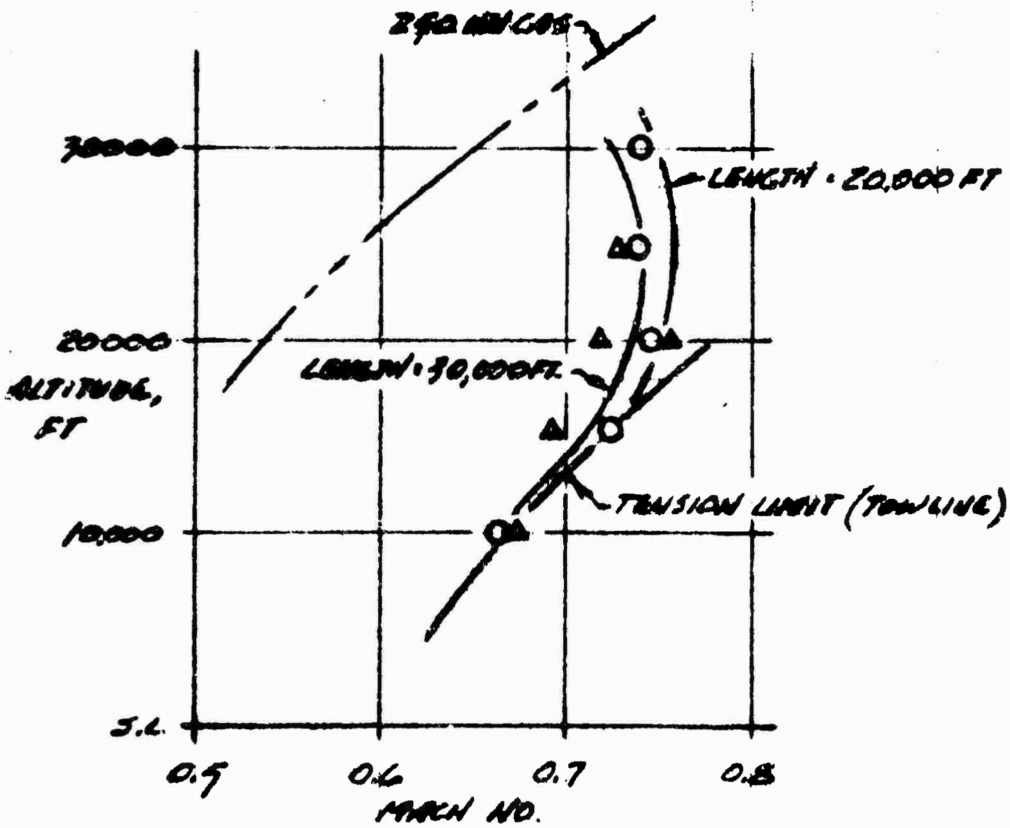
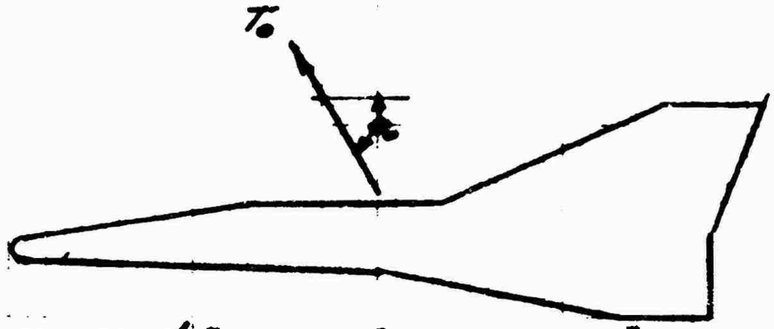


FIGURE A-1 TOWING TEST RESULTS - NADC NA-4C

B. PROFILE FIGHTER TARGET (FIGAT) DATA



$$\theta = \tan^{-1}\left[0.328 + \left(96.037\, N_z / q\right)\right]$$

$$T_0 = \left[4.344\, q / \cos\theta\right]$$

FOR TARGET + TOWLINE DRAG ESTIMATES, SEE FIGURE A-2

C. A-4 TOWING SYSTEM PERFORMANCE ESTIMATION

DATA PROVIDED ON FIGURE A-3 CONSIDERING ENGINE DIFFERENCES ONLY

TOWLINE LENGTH (l) 1000 FT, 2000 FT, 6000 FT, 10,000 FT, $N_z = 1$

THRUST WITH W-20 & P-6 ENGINE MARGINAL FOR MANEUVER AT 20,000 FT., ALTITUDE

D. TOWING LOADS FOR CONTINUOUS TURNS

1. DATA SOURCE

ORBITING PROGRAM DEVELOPED FROM TACAMO, - NADC-AM-6849, FOR NSTTS
SAMPLE IN-PUT, OUT-PUT PAGES A-73 THROUGH A-8...
DATA IN CYLINDRICAL CO-ORDINATES.
SEE MANEUVERING FORMULAS, PAGE A-8, FOR CALCULATION OF INPUT DATA AND CONVERSION TO ROLLED FLIGHT AXIS.

2. OUT-PUT DATA

SEE FIGURE A-4 FOR TOWING LOADS
SEE TABLE A-I FOR DATA SUMMARY
N_z' & V' ARE TARGET N_z & TRUE AIRSPEED (KNOTS)

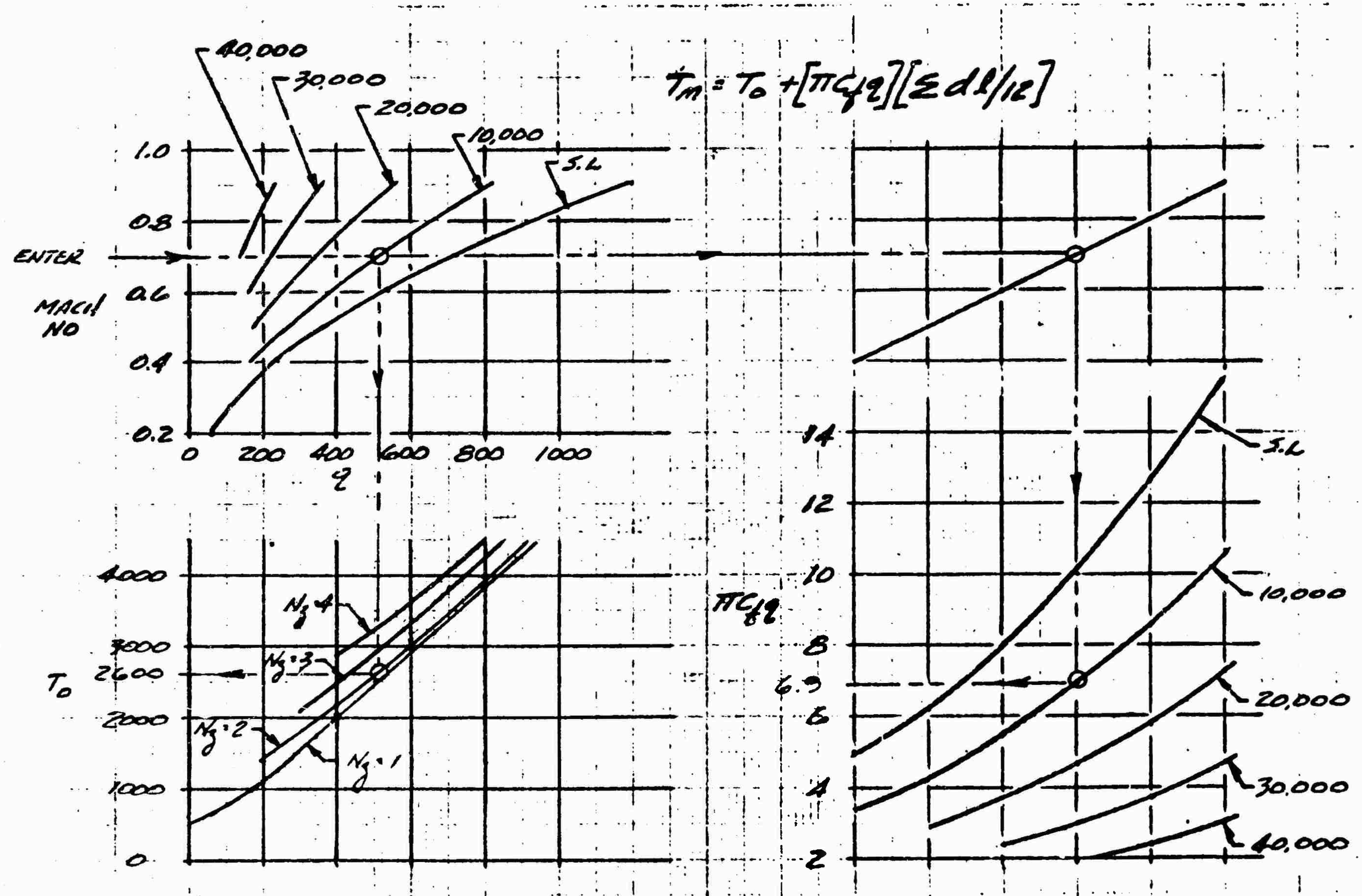


FIGURE A-2 TOWLINE TENSION AT TOWPLANE (T_m)
PROFILE FIGHTER TOWED TARGET (FIGAT)

CONFIGURATION

2 300 GAL. WING TANKS

REEL-LCHR ON ℄

ENGINES: W-20 (W-20)

J52-P-6 (P-6)

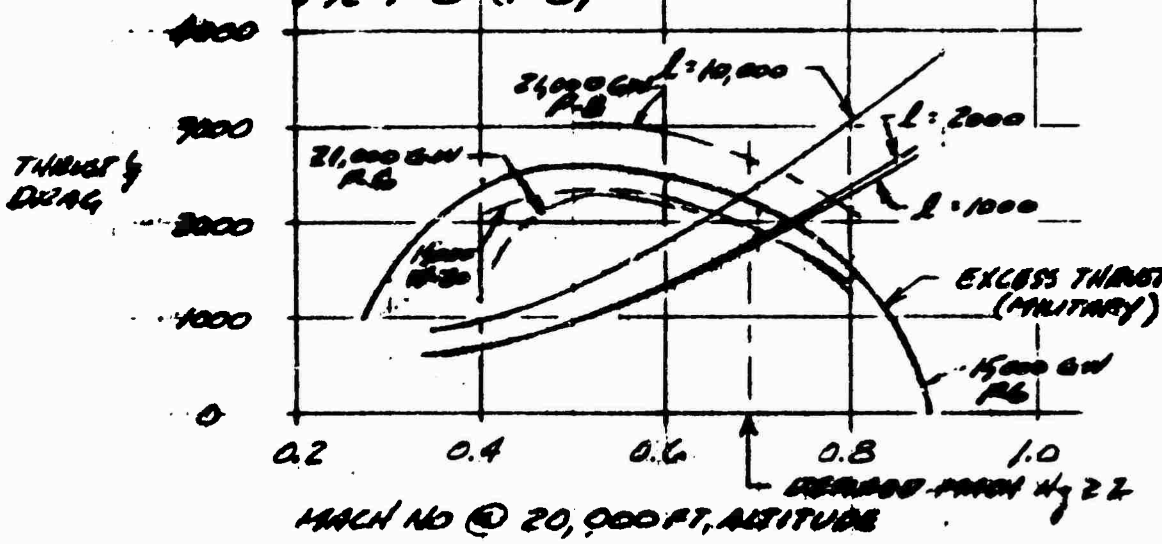
J52-P-8 (P-8)

DRAG INCREMENT-MANEUVER

$N_z = 1$ 0 LBS

$N_z = 2$ 600 LBS

$N_z = 3$ 800 LBS



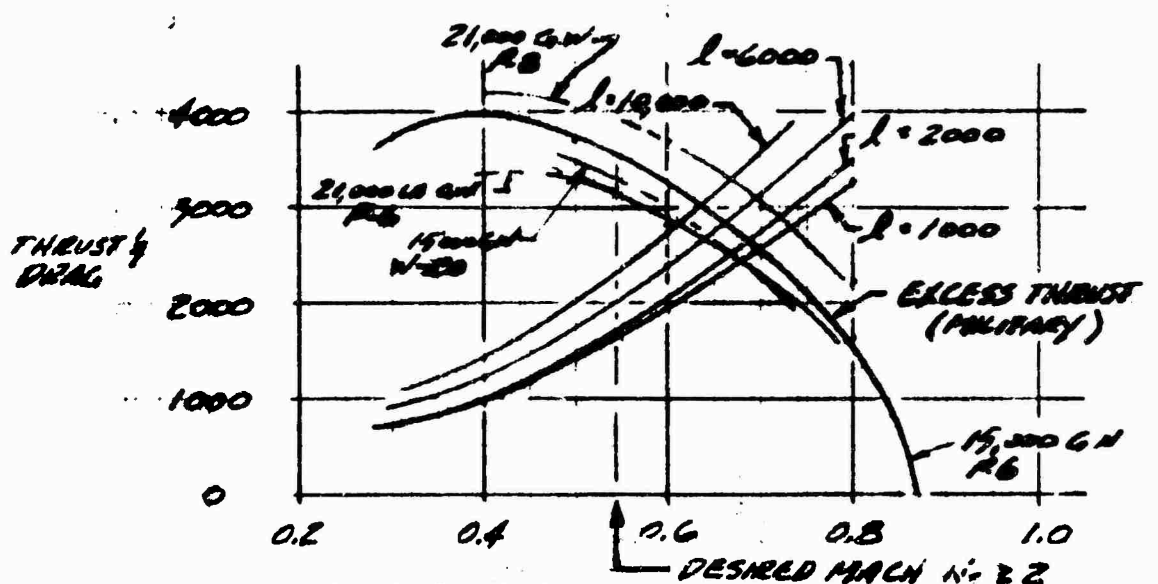


FIGURE A-7 A-4 TOWING SYSTEM PERFORMANCE ESTIMATE - PROFILE FIGHTER TARGET (FIGAT)

E. MANEUVERING FORMULAS

1. TURN RADIUS (KNTAS & N_z INPUT)

$$r_{xy} = V^2 / g \tan\phi = 0.0887 (KNTAS)^2 / (N_z^2 - 1)^{0.5}$$

2. PULL-UP RADIUS (KNTAS & N_z INPUT)

$$r_{xz} = V^2 / g (N_z - 1) = 0.0887 (KNTAS)^2 / (N_z - 1)$$

3. AIRSPEED (KNTAS) - N_z & r INPUT

$$(KNTAS) = 3.3583 \left[r (N_z^2 - 1)^{0.5} \right]^{0.5}$$

4. TOWLINE LOADS ON LAUNCHER (DATA FROM ORBITING PROGRAM)

P = TOWLINE LOAD VECTOR LENGTH
Δl = LAST LENGTH INCREMENT OF TOWLINE AT TOWPLANE
Δr = EQUIVALENT RADIUS INCREMENT
Δz = EQUIVALENT ALTITUDE INCREMENT
x', y', z' ARE ROLLED FLIGHT AXES WITH (0,0,0) AT REEL-LAUNCHER TOW POINT - POSITIVE FORCES ACTING AFT, DOWN & INTO TURN

$$P_{z'} = \cos\left[\cos^{-1}\left(\frac{1}{N_z}\right) - \tan^{-1}\left(\frac{\Delta r}{\Delta z}\right)\right] (\Delta r^2 + \Delta z^2)^{0.5}$$

$$P_{y'} = \sin\left[\cos^{-1}\left(\frac{1}{N_z}\right) - \tan^{-1}\left(\frac{\Delta r}{\Delta z}\right)\right] (\Delta r^2 + \Delta z^2)^{0.5}$$

$$RP_{x'z'} = \Delta l \cos\left[\sin^{-1}\left(\frac{P_{y'}}{\Delta l}\right)\right]$$

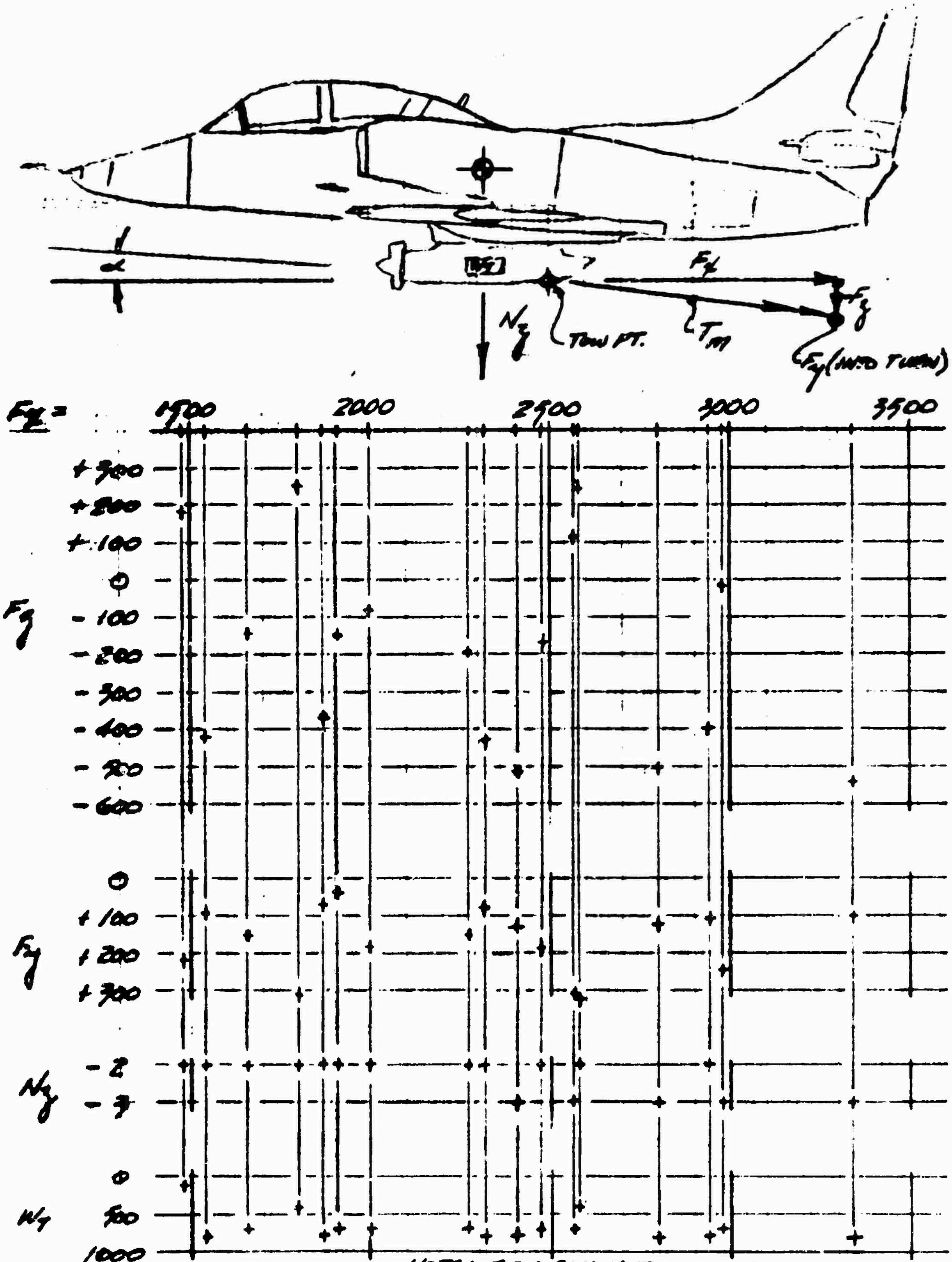
$$P_{x'} = \cos\left[\sin^{-1}\left(\frac{P_{z'}}{RP_{x'z'}}\right)\right] RP_{x'z'}$$

ρ = FRACTION OF TOWLINE LOAD EQUIVALENT TO VECTOR LENGTH
T_M = TOWLINE TENSION AT TOWPLANE

$\rho = P / \Delta l$

F = FORCE APPLIED BY TOWLINE

$F = \rho T_M$



NOTE: SIGN CONVENTION PER MIL-A-8591

FIGURE A-4 TOWING LOADS SUMMARY
PROFILE FIGHTER TARGET (FIGAT) & 0.182 3X7 CABLE

DATA SHEET
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TABLE A-I

TOWING LOADS SUMMARY - PROFILE FIGHTER TARGET (FIGAT)													
INPUT DATA - ORBITING PROGRAM								OUTPUT DATA					
ALT.	MACH	πC_d	C_{D_0}	TAS	N_q	r	ℓ	T_m	P_z'	P_y'	P_x'	N_z'	V'
10,000	0.7	0.0138	1.64	447	3	6364	7000	3340	.1587	.0287	.9869	3.12	466
	0.6	0.0150	1.51	384	3	4622		2741	.1748	.0442	.9832	3.19	411
	0.5	0.0170	1.40	319	3	3190		2475	.2097	.0530	.9763	3.33	358
	0.7	0.0138	1.64	447	2	10228		2936	.1366	.0366	1.0000	2.04	458
	0.6	0.0150	1.51	384		7548		2365	.1812	.0339	.9828	2.05	397
	0.5	0.0170	1.40	319		5209		[illegible]	.1949	.0376	.9801	2.09	338
10,000	0.4	0.0210	1.30	256		3355	1000	1603	.2632	.0559	.9631	2.17	285
20,000	0.7	0.0138	1.64	430		9465	2000	[illegible]	.0846	.0666	.9942	2.06	446
20,000	0.6	0.0150	1.51	369		6970		1926	.0760	.0716	.9945	2.07	390
20,000	0.5	0.0170	1.40	307	2	4859		1667	.0860	.0829	.9960	2.15	337
10,000	0.6	0.0150	1.51	384	3	4622		2986	.0079	.0821	.9966	3.22	415
	0.5	0.0170	1.40	319	3	3190		2598	-.0420	.1210	.9918	3.35	361
	0.6	[illegible]	1.51	384	2	7548		2491	.0673	.0766	.9971	2.06	400
	0.5	[illegible]	1.40	319		[illegible]	2000	2019	.0415	.0916	.9949	2.11	341
	[illegible]	[illegible]	1.51	384		[illegible]	6000	[illegible]	-.0941	.1271	.9919	1.99	380
	0.5	[illegible]	1.40	319		[illegible]	6000	1851	-.1363	.1699	.9760	1.91	300
10,000	0.5	[illegible]	1.40	319	[illegible]	[illegible]	10,000	1569	-.1212	.1462	.9818	1.65	241

NOTE: SIGN OF P_z' OPPOSITE OF MIL-A-8591

PLATE NO 13038

F. REEL-LAUNCHER STORE CHARACTERISTICS

1. DATA SOURCE
   a. ACTUAL WT & BALANCE RMU-8/A (S/N 022)
      SEE FIGURE A-5
   b. ACTUAL WT. REPORT (TMC-0538-36-1)
      RMK-19/A47U-3 (FA-3)
      SEE FIGURE A-6 FOR REFERENCE DATA

2. MOMENT OF INERTIA ESTIMATES FOR RMU-8/A (S/N 022)

$$I_{xx} = W' z'^2 + \Delta W z^2 - W z^2 + I'_{xx}$$

$$= (809.8)(1.6)^2 + (56.2)(-1.5)^2 - (866)(1.4)^2 + 35401$$

$$= 35903. \text{ LB}\cdot\text{IN}^2 \text{ — USE } 36{,}000 \text{ LB}\cdot\text{IN}^2 \ (k = 6.5)$$

$$I_{yy} = W' x'^2 + \Delta W x^2 - W x^2 + W' z'^2 + \Delta W z^2 - W z^2 + I'_{yy}$$

$$= (809.8)(62.3)^2 + (56.2)(8.4)^2 - (866)(58.8)^2 + (809.8)(1.6)^2 + (56.2)(-1.5)^2 - (866)(1.4)^2 + 821913$$

$$= 975{,}306 \text{ LB}\cdot\text{IN}^2 - \text{USE } 976{,}000 \text{ LB}\cdot\text{IN}^2 \ (k = 33.6)$$

$$I_{zz} = W' x'^2 + \Delta W x^2 - W x^2 + I'_{zz}$$

$$= (809.8)(62.3)^2 + (56.2)(8.4)^2 - (866)(58.8)^2 + 816512$$

$$= 969{,}403 \text{ LB}\cdot\text{IN}^2 - \text{USE } 970{,}000 \text{ LB}\cdot\text{IN}^2 \ (k = 33.5)$$

SEE FIGURE A-7 FOR EQUIVALENT STORE DATA APPLICABLE TO A-4 AERO-7A INSTALLATION

3. MOMENT OF INERTIA ESTIMATES FOR VARIABLE TOWLINE SPOOL LOADING

   SEE TABLE A-II

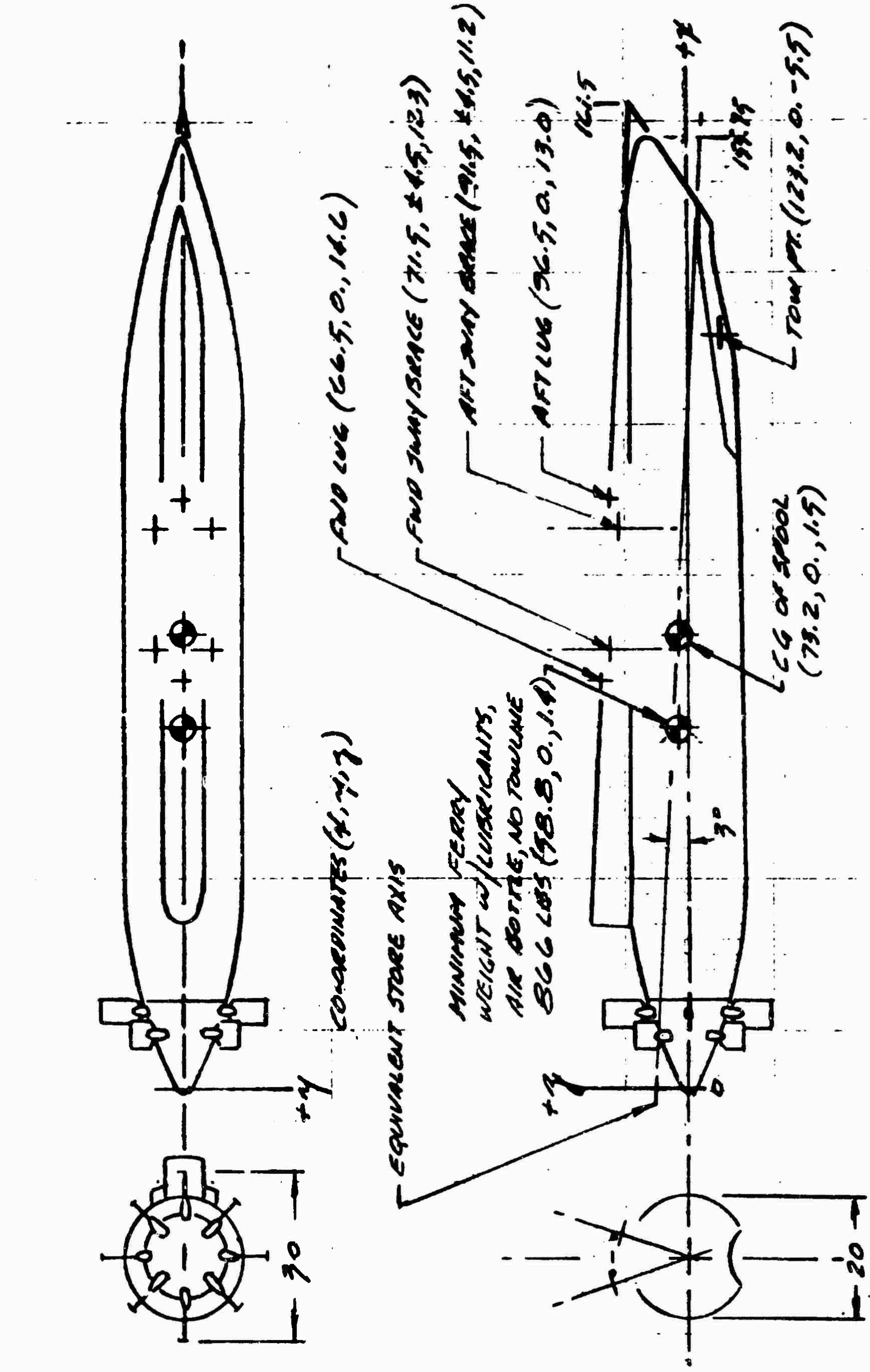

FIGURE A-5 DIMENSIONAL & WEIGHT & BALANCE DATA EPMU-8/A S/N 022

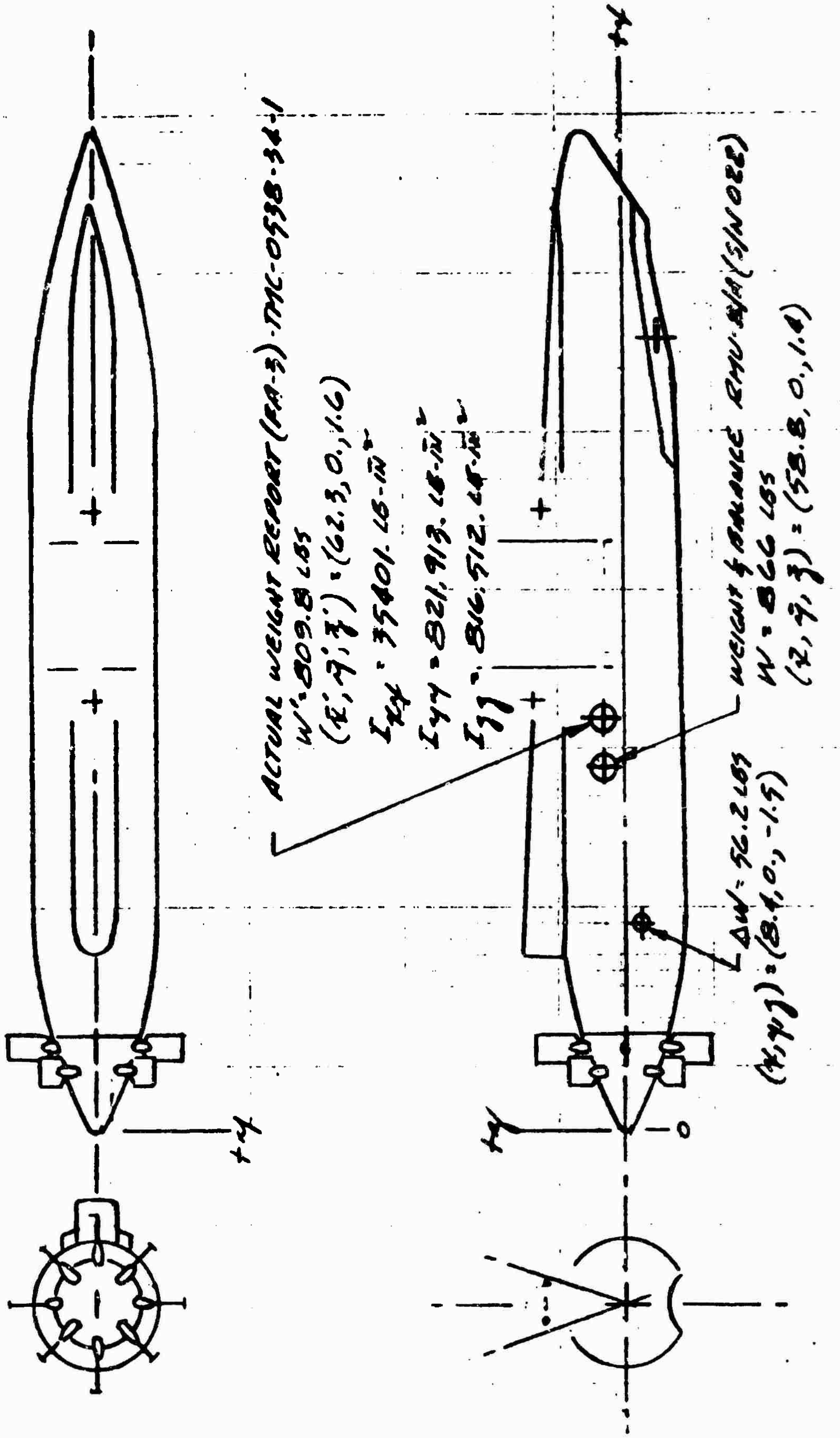

FIGURE A-6 DIFFERENCE DATA - RMK-19/A37U-3 & RMU-8/A

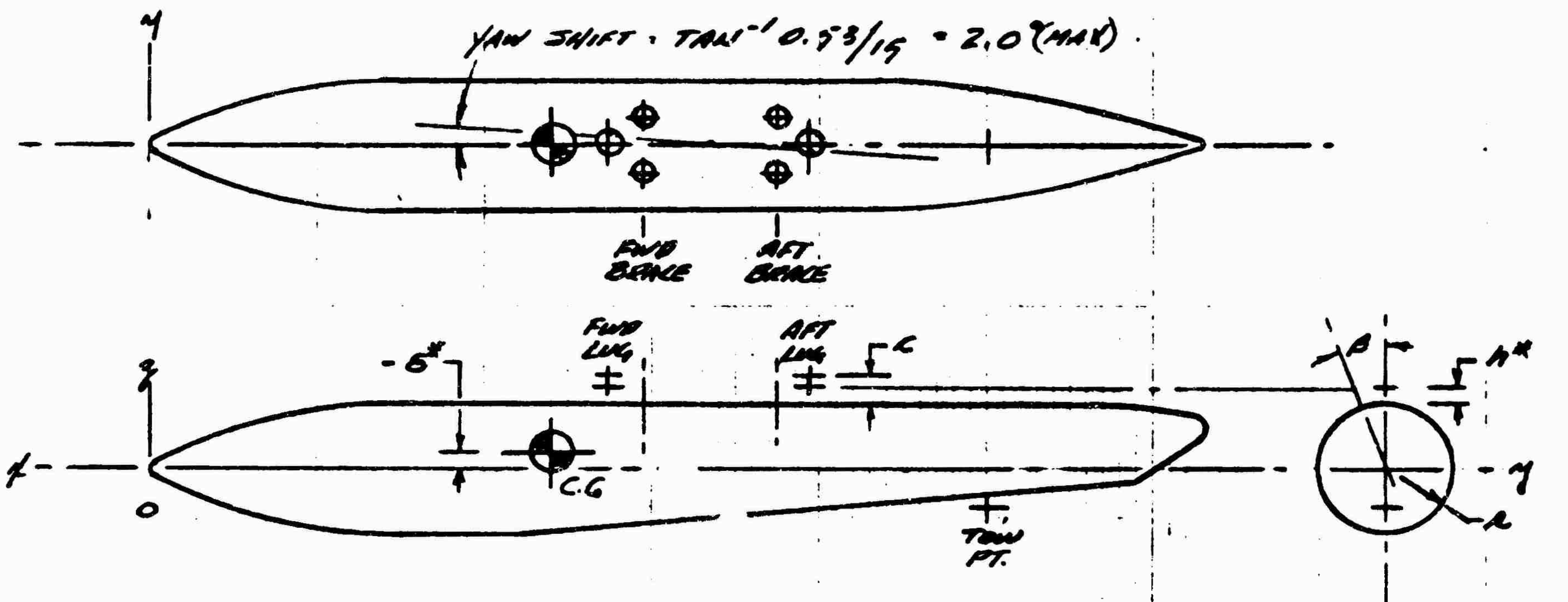

FIGURE A-7 RMU-8/A, RMK-19/A47U-3 EQUIVALENT STORE DATA

A/C TYPE	A-4	REEL TYPE	RMU-8/A
RACK TYPE	AERO 7A	REEL S/N	022

DIMENSIONAL DATA	x	y	z
FWD LUG	65.8	0	13.5
AFT LUG	95.8	0	13.5
FWD BRACE	70.8	±4.5	11.4
AFT BRACE	90.8	±4.5	11.4
TOW PT	123.6	0	-3.6
C.G NO TOWLINE	58.8	0	0

I_{xx}	I_{yy}	I_{zz}
36,000	976000	970,000

$R = 12.3$ NOTE YAW SHIFT

$C = 1.6$

$h^* = 1.2$

$\beta = 21.5$

$E^* = 0.0$

$W = 866.$ NO TOWLINE

DATA SHEET
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TABLE A-II

RMU-8/A S/N 022 WEIGHT, C.G & MOMENTS OF INERTIA w/ 0.182 3X7 CABLE

ITEM	WEIGHT	x	wx	wx^2	ΔI_x	ΔI_y	ΔI_z	W	Σwx	x_{cg}	Wx_{cg}^2	I_{xx}	I_{yy}	I_{zz}
Reel	866	58.8	50921	2994103	36,000	976,000	970,000	866	50921	58.8	2994144	36,000	976,000	[illegible]
[illegible]	703	73.2	51460	3766849	16376	142099	142039	1569	102381	65.3	6690358	52,376	[illegible]	[illegible]
l=2000	573	↑	41945	3070272	11831	115015	115015	1439	92866	64.6	5993117	47,891	[illegible]	[illegible]
l=6000	313	↓	22912	1677130	4806	61998	61998	1179	73833	62.7	4639675	40,806	[illegible]	[illegible]
l=10000	52	73.2	3807	278629	524	10163	10163	918	54728	59.7	3262695	36,524	[illegible]	990240

$g = 386\ in/sec^2$

TOWLINE MOMENT OF INERTIA (#-IN²)

$$\Delta I_x = \frac{W}{2}\left[\frac{12d^2 l \times 10^3}{47.8\pi} + 18\right]$$

$$\Delta I_y = \Delta I_z = \frac{W}{4}\left[\frac{12d^2 l \times 10^3}{47.8\pi} + 778.6\right]$$

PARALLEL AXIS (#-IN²)

$$I_{xx} = \Sigma \Delta I_x$$

$$I_{yy} = \Sigma wx^2 - Wx_{cg}^2 + \Sigma \Delta I_y$$

$$I_{zz} = \Sigma wx^2 - Wx_{cg}^2 + \Sigma \Delta I_z$$

$$\Sigma \Delta I_y - \Sigma \Delta I_z = 6000$$

PLATE NO. 13038

G. REEL-LAUNCHER AERO LOADS

1. DATA SOURCE

TPR 0598-13-1

DATA IS CORRECTED FOR

a. 30 IN-DIA PWR UNIT

b. CALCULATION ERRORS

c. PYLON DRAG

d. PWR UNIT C_{N_α} & C_{N_β}

2. AERODYNAMIC DERIVATIVES - DRAG

$$C_{D_{STORE}} = C_{D_o} + C_{D_P} + (\alpha^2+\beta^2) + C_{D_{BF}}$$

$$C_{D_o} = 0.105 \ , \ 0.4 \le M \le 0.9$$

$$C_{D_{BF}} = 0.0307$$

C_{D_P} = PYLON DRAG COEFFICIENT

$$= C_{D_{CROSS}} \frac{A_{CROSS}}{A_{REF}}$$

$$A_{REF} = 2.18 \ \square'$$

$$A_{CROSS} = \underbrace{(6.5)(9)}_{t_{MAX} @ L.E.} + \underbrace{(2)(3)(3)}_{t_{S.B FAIRS}} = 76.5 \ \square''$$

$$C_{D_{CROSS}} = 5.3 \frac{t/c}{(M^2-1)} = \frac{(5.3)(6.5)}{(12)^2(1.5^2-1)} = 0.191$$

$$C_{D_P} = \frac{(0.191)(76.5)}{(2.18)(144)} = 0.0466$$

$$C_{D_{STORE}} = 0.1823 + (\alpha^2+\beta^2) \ , \ 0.4 \le M \le 0.9$$

NOTE - OTHER ESTIMATE 0.1556 FOR RMU-8/A WITH 26"-D UNIT BASED ON F-4 DRAG COUNTS

3. AERODYNAMIC DERIVATIVES - NORMAL FORCE

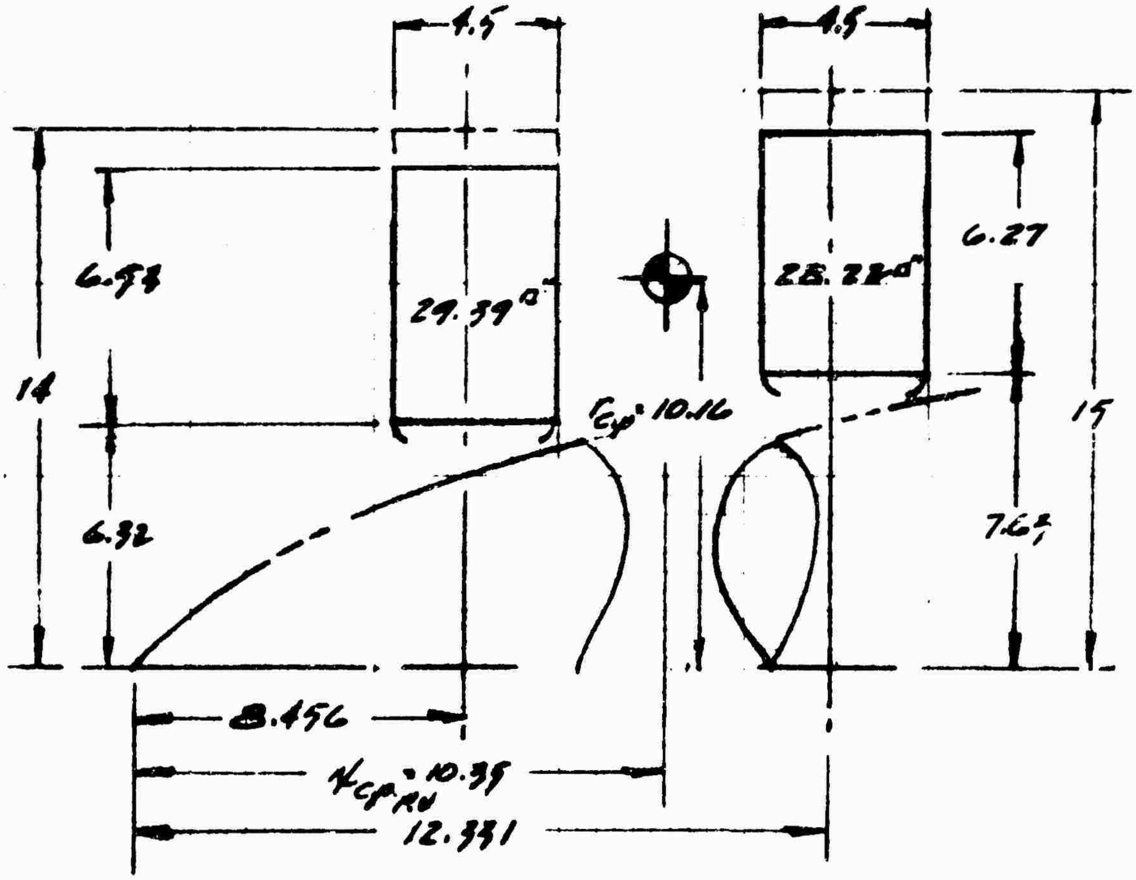
CONSIDER $C_{L_{\alpha}} = C_{N_{\alpha}} = C_{N_{\beta}} = C_{N_{\alpha(\beta)}}$

POD ONLY

$C_{N_{\alpha(\beta)}POD} = 2.00$

PWR UNIT ONLY

(REF. TMC S-1236)



Q = TORQUE, '-#

A_{BLADES} = EFFECTIVE BLADE AREA

r_{cp} = TORQUE RADIUS, ' = 10.16/12

$C_{L_{BLADE}}$ = BLADE LIFT COEFFICIENT

$x_{cp_{PU}}$ = CENTER OF PRESSURE FOR PWR. UNIT = 10.35 IN.

$Q = C_Q q A_{TRANS} r_{c.p.} = 2 Q_c q D^3$

Q_c : TORQUE COEFFICIENT (NADC-73086-30)

$D^3 = (30/12)^3 = 15.625 \; FT^3$

F_T = FORCE APPLIED AT RADIUS $r_{c.p.}$

$$F_T = \frac{2 Q_c q D^3}{r_{c.p.}} = 36.91 \; Q_c q$$

F_N = NORMAL FORCE APPLIED AT $x_{c.p._{PU}}$

$$F_N = F_T \left[\frac{2 + (4)(0.707)}{8} \right] = 22.28 \; Q_c q$$

SEE FIGURE A-8 FOR PLOTTED DATA

$$C_{N\alpha(\beta)_{PU}} = 1.59 \;, \; 0 < \alpha(\beta) \leq 0.05$$
$$= 1.64 - 2.26 \, \alpha(\beta) \;, \; 0.05 < \alpha(\beta) \leq 0.25$$

NOTE - $C_{N\alpha(\beta)_{PU}}$ NOT CONSIDERED IN ANY PREVIOUS ANALYSIS

4. <u>AERODYNAMIC DERIVATIVES - PITCH & YAW MOMENTS</u>

<u>POD ONLY</u>

$$C_{m_{POD}} = C_{m\alpha(\beta)_{POD}} = \left\{ x_m - x_{c.p._{POD}} \right\} C_{N\alpha(\beta)_{POD}} \alpha(\beta)$$

$l_{REF} = 155.75$

$x_m = x_{c.g.}/155.75$

$x_{c.p._{POD}} = 0.12 \; (\% \; l_{REF})$

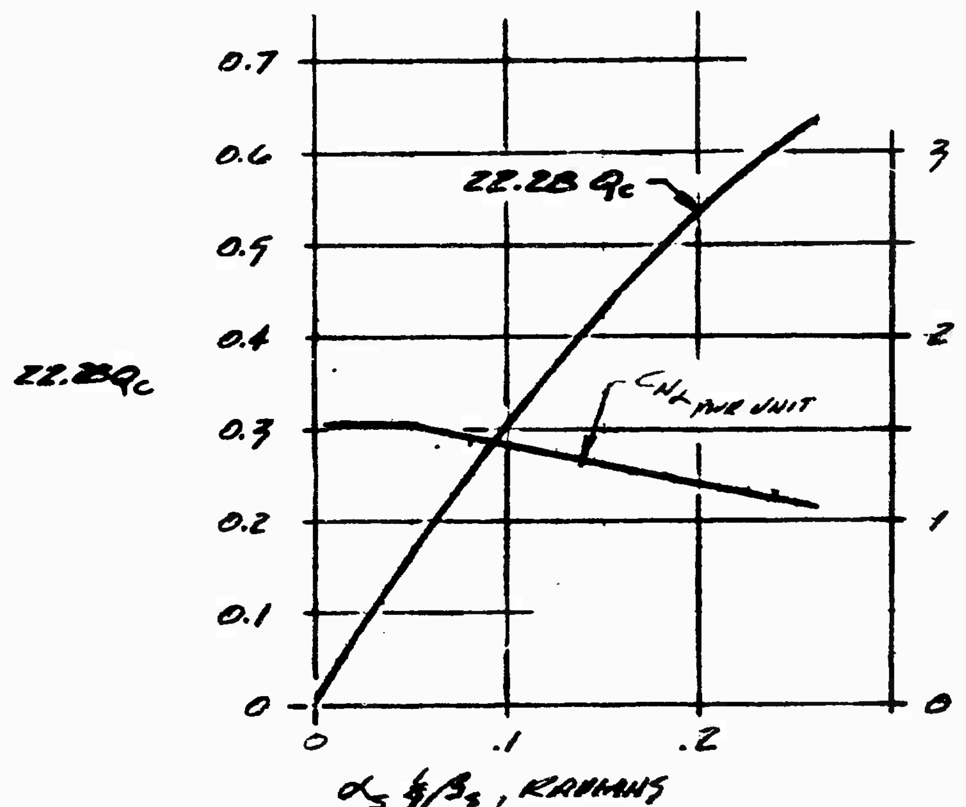
$x_{c.p._{POD}} = 0.12(155.75) = 18.69$

<u>PWR UNIT</u>

$$C_{m_{P.U.}} = C_{m\alpha(\beta)_{PU}} = \left\{ x_m - x_{c.p._{PU}} \right\} C_{N\alpha(\beta)_{P.U.}} \alpha(\beta)$$

$x_{c.p._{PU}} = 10.35$

REF: NADC-73086-30



$22.28\ Q_c / 2.18\alpha = C_{N_{\alpha}(\beta)}$ PWR UNIT

$C_{N_{\alpha}(\beta)}$ PWR UNIT $= 1.53 \quad 0 < \alpha(\beta) < 0.05$

$= 1.64 - 2.26\alpha(\beta) \quad 0.05 < \alpha(\beta) < 0.25$

FIGURE A-8 NORMAL FORCE COEFFICIENTS FOR 30 IN-DIA PWR UNIT

5. AERODYNAMIC DERIVATIVES - SUMMARY

SEE FIGURE A-9
APPROPRIATE FOR HEAVY DUTY REEL-LAUNCHER
(RMK-19/A47W-9 & RMU-8/A w/30IN-DIA PWR. UNIT)

6. FLIGHT CONDITIONS FOR AIRLOADS - A-4 TOW CONFIG.

a. FERRY - 0.8M @ S.L., 530 KN (CAS)

$q = 975\ \#/\square'$

$\alpha_{A/C} = 0°, +5°$ (2° TYPICAL FOR A-4)

$\beta_{A/C} = \pm 2°$

b. TOWING - 0.65M @ S.L., 430 KN (CAS)

$q = 640\ \#/\square'$

$\alpha_{A/C} = 0°, +8°$ (4° TYPICAL FOR A-4)

$\beta_{A/C} = \pm 3°$

7. STORE AIRLOAD CONDITIONS

SEE TABLE A-III

F1

$q = 975\ \#/\square'$

$\alpha_S = -0.052$ RADIANS

$\beta_S = -0.035$ RADIANS

F2

$q = 975\ \#/\square'$

$\alpha_S = +0.035$ RADIANS

$\beta_S = -0.035$ RADIANS

T1

$q = 640\ \#/\square'$

$\alpha_S = -0.052$ RADIANS

$\beta_S = -0.052$ RADIANS

T2

$q = 640\ \#/\square'$

$\alpha_S = +0.087$ RADIANS

$\beta_S = -0.052$ RADIANS

ALTERNATE CONDITIONS INCLUDE YAW SHIFT IN RACK - SEE TABLE A-IV

$\tan^{-1} 0.53/15 = 2.0$

$\beta_S = -0.070$ (F1A & F2A)

$\beta_S = -0.087$ (T1A & T2A)

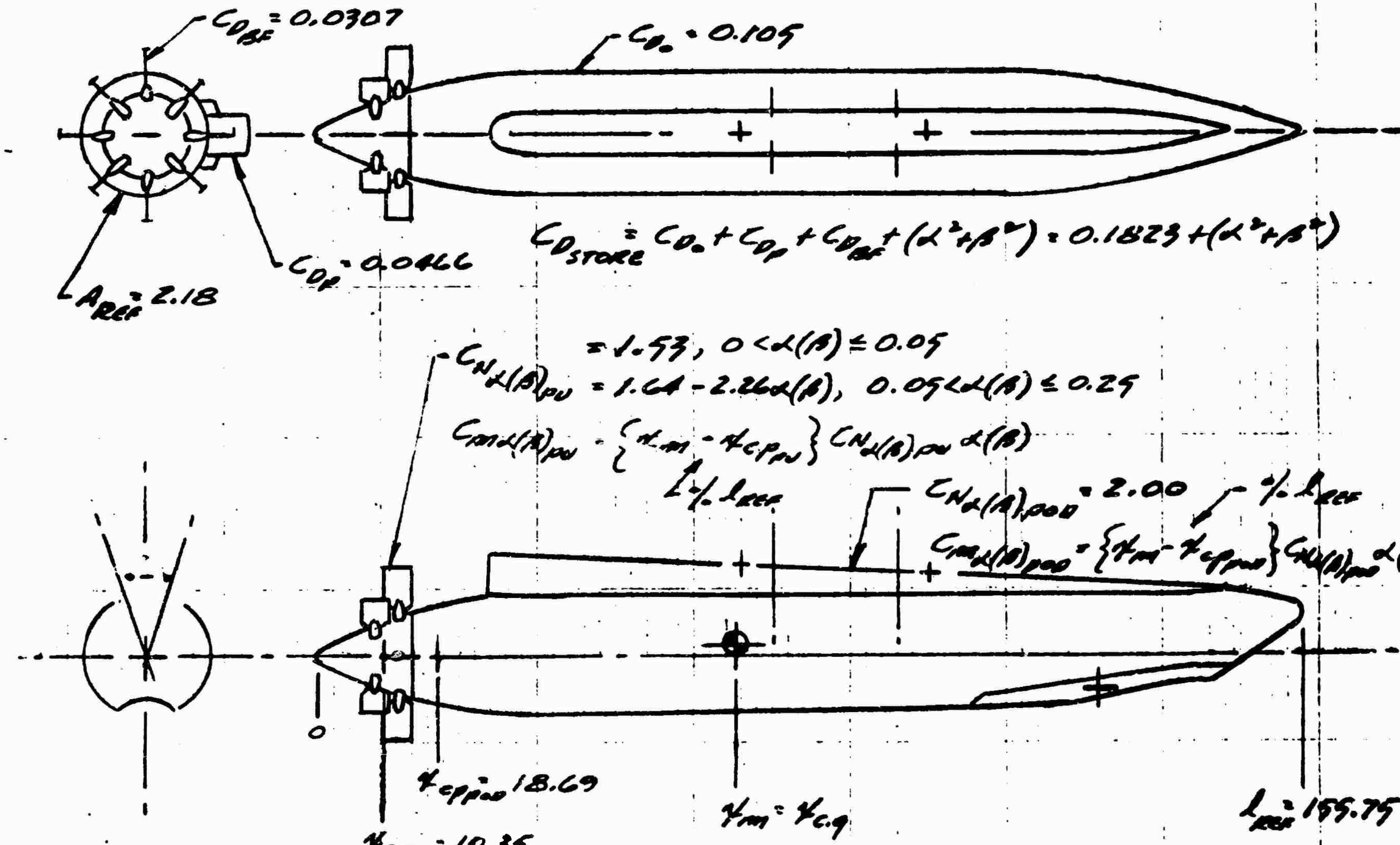


FIGURE A-9 AERODYNAMIC DERIVATIVES SUMMARY
HEAVY-DUTY REEL-LAUNCHER
$0.4 \leq M \leq 0.9$

DATA SHEET
4ND-NADC-3980/11

TABLE A-III

RMU-8/A S/N 022-A4 ℄ INSTL. (AERO 7A) - AIRLOADS β_s : 2°

MISSION	FERRY (No Tgt.)		TOWING		MISSION	FERRY (No Tgt)		TOWING	
COND	F1	F2	T1	T2	COND	F1	F2	T1	T2
q	975	975	640	640	AP_x	396	393	262	269
α_s	-0.052	+0.035	-0.052	+0.087	AP_y	-389	261	-255	419
β_s	-0.035	-0.035	-0.052	-0.052	AP_z	-261	-261	-255	-255
Hm-Hg Stored(P)	+0.229	+0.229	+0.295	+0.295	AM_y	-19532	13242	-12821	20644
Hm-Hg PU(P)	+0.353	+0.353	+0.348	+0.348	AM_z	-13242	-13242	-12821	-12821
Hm(P)	+0.419	+0.419	+0.415	+0.415					
C_{D_s}	0.186	0.185	0.188	0.193					
$C_{N_y s}$	-0.104	+0.070	-0.104	+0.174					
$C_{N_y PU}$	-0.079	+0.053	-0.079	+0.126					
$C_{N_z s}$	-0.070	-0.070	-0.104	-0.104					
$C_{N_z PU}$	-0.053	-0.053	-0.079	-0.079					
$C_{M_y s}$	-0.031	+0.021	-0.031	+0.051					
$C_{M_y PU}$	-0.028	+0.019	-0.028	+0.044					
$C_{M_z s}$	-0.021	-0.021	-0.031	-0.031					
$C_{M_z PU}$	-0.019	-0.019	-0.028	-0.028					

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DATA SHEET
4NO-NADC-3960/11

TABLE A-IV

RMU-8/A S/N 022 - A4 ℄ INSTL. (AERO 7A) - AIRLOADS, β_s = 4°														
MISSION	FERRY (No TGT.)		TOWING				MISSION	FERRY (No TGT)		TOWING				
COND	F1A	F2A	T1A	T2A			COND	F1A	F2A	T1A	T2A			
q	975	975	640	640			AP_x	404	400	269	275			
α_s	−0.052	+0.035	−0.052	+0.087			AP_y	−389	261	−255	419			
β_s	−0.070	−0.070	−0.087	−0.087			AP_z	−517	−517	−419	−419			
H_m-H_{cp} Store (P)	+0.299	+0.299	+0.295	+0.295			AM_y	−19532	13242	−12821	20644			
H_m-H_{cp} Pu. (P)	+0.353	+0.353	+0.348	+0.348			AM_z	−25822	−25822	−20644	−20644			
H_m (P)	+0.419	+0.419	+0.415	+0.415										
C_{D_s}	0.190	0.188	0.193	0.197										
$C_{N_z s}$	−0.104	+0.070	−0.104	+0.174										
$C_{N_z PU}$	−0.079	+0.053	−0.079	+0.126										
$C_{N_y s}$	−0.140	−0.140	−0.174	−0.174										
$C_{N_y PU}$	−0.103	−0.103	−0.126	−0.126										
$C_{M_y s}$	−0.031	+0.021	−0.031	+0.051										
$C_{M_y PU}$	−0.028	+0.019	−0.028	+0.044										
$C_{M_z s}$	−0.042	−0.042	−0.051	−0.051										
$C_{M_z PU}$	−0.036	−0.036	−0.044	−0.044										

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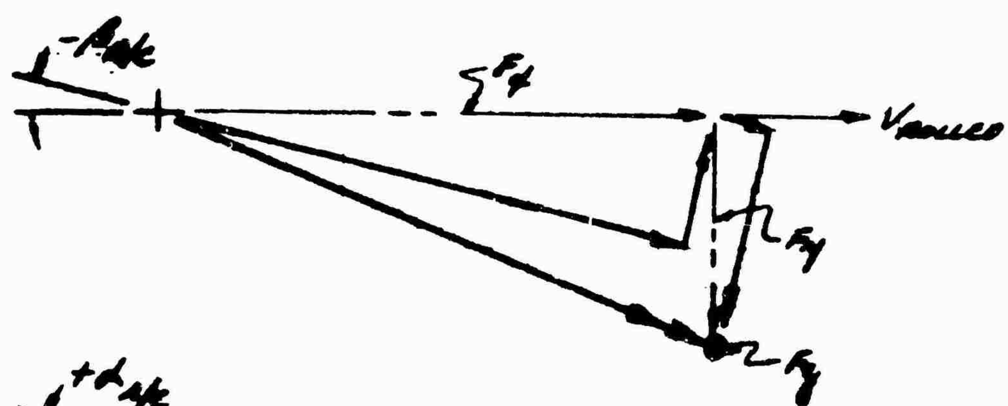
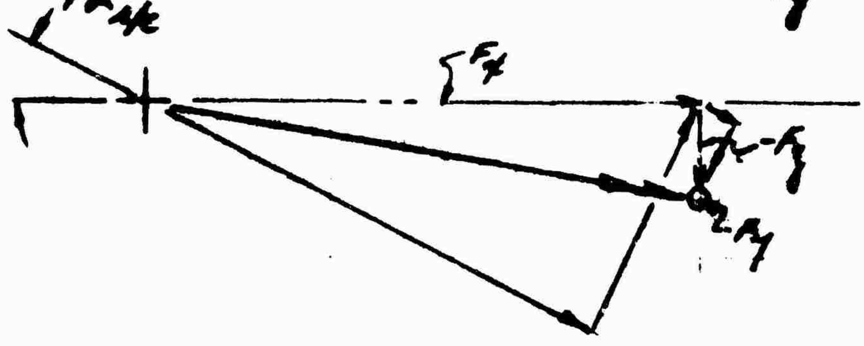
B. STORE AIRLOADS - DUE TO TOWLINE FORCES

SOLUTION FOR LOADS APPLIED PARALLEL & NORMAL TO AIRPLANE AXES OR EQUIVALENT STORE AXES (ROLLED, PITCHED & YAWED IN AIRSPACE) - DATA ON FIGURE A-4 IS ROLLED ONLY

SIGN CONVENTION PER MIL-A-8591





$$TP_x = F_x \cos\alpha_{A/C} \cos\beta_{A/C} \pm F_z \sin\alpha_{A/C} \cos\beta_{A/C} - F_y \sin\beta_{A/C}$$

$$TP_y = F_y \cos\beta_{A/C} + F_x \sin\beta_{A/C}$$

$$TP_z = -F_z \cos\alpha_{A/C} \pm F_x \sin\alpha_{A/C}$$

N. SUSPENSION SYSTEM

1. DATA SOURCE

LOADS PROGRAM DEVELOPED FOR FUEL TANKS.
SAMPLE IN-PUT, OUT-PUT PGS A-88 THROUGH A-97.
CALCULATES MIL-A-8591 (D OR E VERSION).
WHEN MX = 0, SB = 1.0, METHOD IS MIL-A-8591D.

AERO 7A STRENGTH DATA DEVELOPED BY
W. BOLLINGER (APPENDIX B).

2. AERO 7A CHARACTERISTICS & LIMIT LOADS

CHARACTERISTICS -

SIDE LOAD REACTED BY SWAY BRACE.
YAWING MOMENT REACTED BY
SWAY BRACES UNTIL M_z IS SUFFICIENT
TO SLIDE STORE - DEFLECTION
REQUIRED IS EQUIVALENT TO $\bar{R}$ FOR
M_z = 65017
R_x IS REACTED BY RACK FRAME
AND IS NOT CRITICAL
R_z IS SHARED BY TWO HOOKS

LIMIT LOADS -

$R_{x\,MAX}$ = NOT CRITICAL
$R_{y\,MAX}$ = 0 (SB = 1.00) - EXPECTED
$M_{z\,MAX}$ < 65017
$R_{z\,MAX}$ = 37,000, $M_{z\,MAX}$ < 65017
$\bar{R}_{MAX}$ = 15,192 / 1.5 (STORE PER FIG. A-7)
= 10,128

APPROACH -

DEFINE LIMIT LOAD FACTOR
ENVELOPES FOR $\bar{R}_{MAX}$ ≤ 10,128
WITHOUT & WITH YAW SHIFT

3. LOADING CONDITION FLIGHT-FERRY $3\theta = 1.00$

CRITICAL LOADING CASES - SEE FIGURES A-10 & A-11

FOR CONTRIBUTION OF COMPONENT LOADS, USE LOADS PROGRAM - PGS A-13 THROUGH A-15

$\bar{R}^t_{R(N_x)} = -(3750/8)N_x = -468.75 N_x$

$\bar{R}^t_{R(N_y)} = -(8187/1.5)N_y = -5391.33 N_y$

$\bar{R}^t_{R(N_z)} = (4115/4.0)N_z = 1028.75 N_z$

$\bar{R}^t_{R(\ddot{\theta})} = (794/12)\ddot{\theta} = 66.17\ddot{\theta}$

$\bar{R}^t_{R(\ddot{\psi})} = -(2508/6)\ddot{\psi} = -418\ddot{\psi}$

F1 AIRLOADS EQUIVALENT TO LOAD FACTORS

$AN_x = 396/1569 = 0.252$

$AN_y = -261/1569 = -0.166$

$AN_z = -389/1569 = -0.248$

$A\ddot{\theta} = (-19532)(386)/(1188667) = -6.343$

$A\ddot{\psi} = (-13242)(386)/(1182667) = -4.322$

$\bar{R}^t_{R(F1)} = (-5391.33)(-0.166) + (-418)(-4.322) = 2702$

F2 AIRLOADS EQUIVALENT TO LOAD FACTORS

$AN_x = 393/1569 = 0.251$

$AN_y = -0.166$

$AN_z = 0.166$

$A\ddot{\theta} = (13242)(386)/(1188667) = 4.300$

$A\ddot{\psi} = -4.322$

$(-468.75)(0.257) + (1028.75)(0.166) + (66.17)(4.300)$

$= 338$ (Xz PLANE LOAD)

$\bar{R}^t_{R(F2)} = 338 + 2702 = 3040$

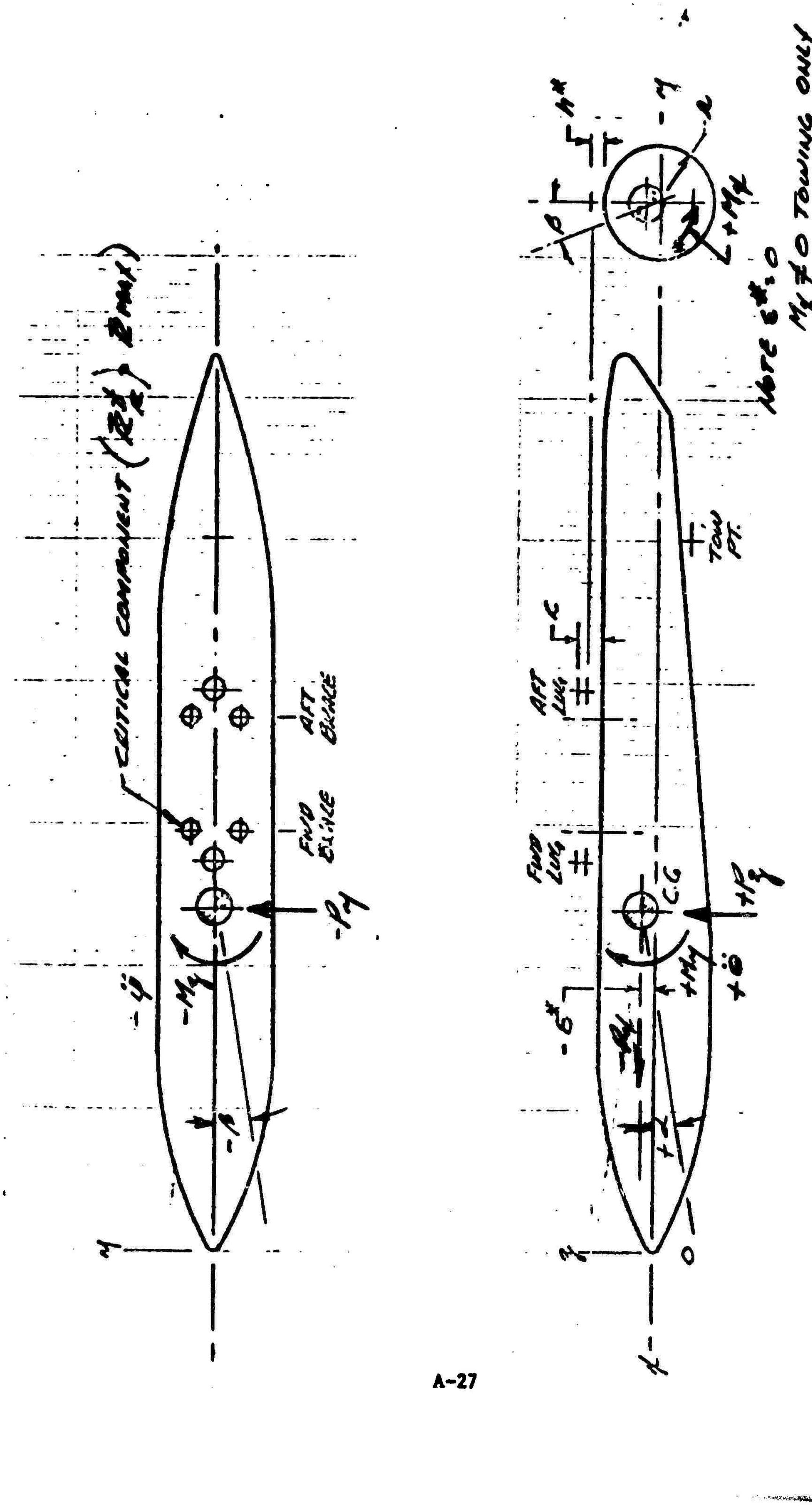


FIGURE A-10 CRITICAL LOADING CASE - SWAY BRACES

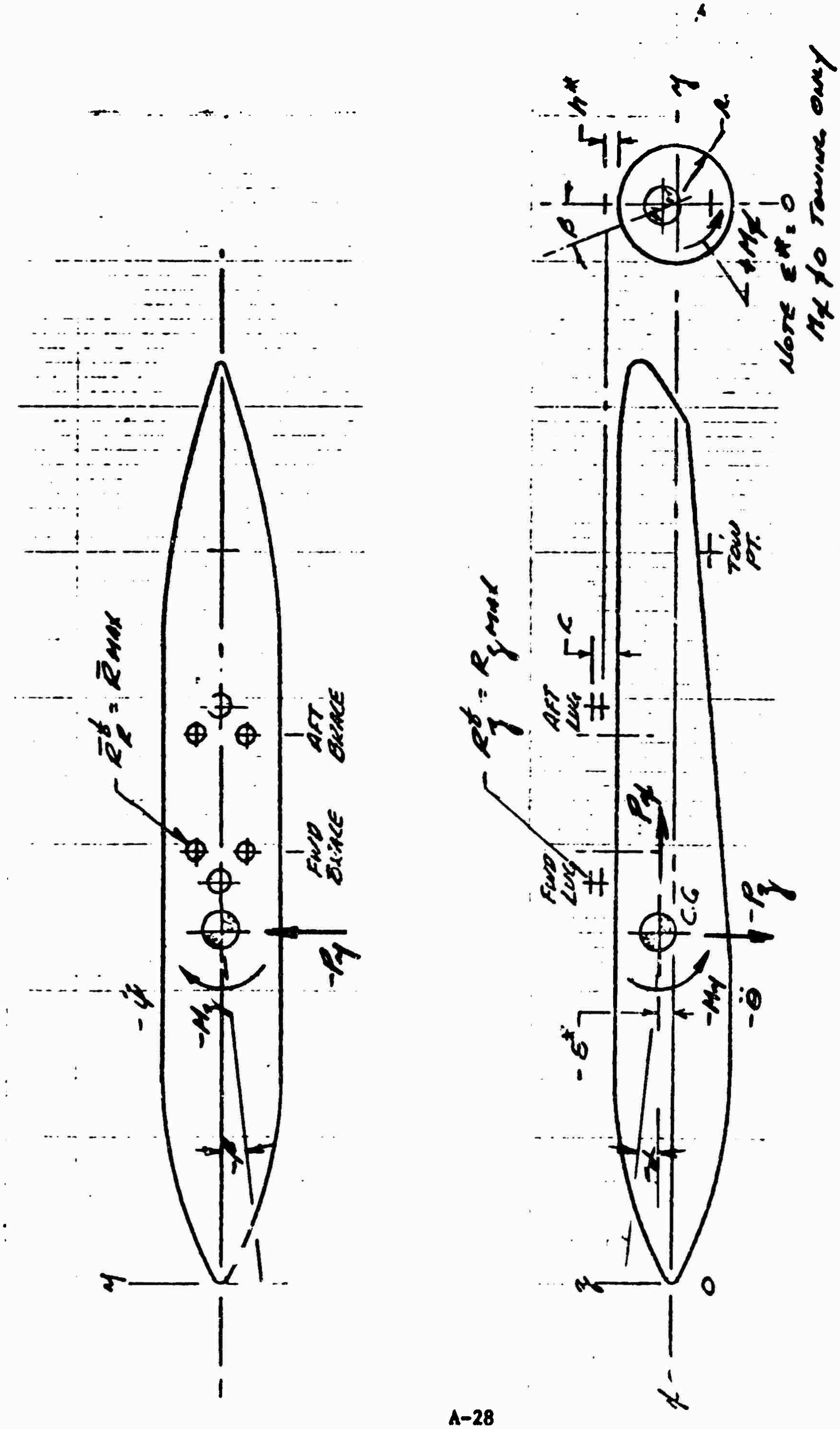


FIGURE A-11 CRITICAL LOADING CASE FWD LUG & SWAY BRACES

$(-468.75)(0.252)+(1028.75)(-0.248)+(66.17)(-6.343)$
$= -793$ (N_y PLANE LOAD FOR F1)

ENVELOPE ESTIMATE – NO YAW SHIFT
F1 & F2 AIRLOADS

ESTIMATE $\bar{R}^t_R$ (F1)

$$\bar{R}^t_R = -468.75 N_x - 5391.33 N_y + 1028.75 N_z + 66.17 \ddot{\theta} - 418 \ddot{\psi} - 793 + 2702$$

$$\bar{R}^t_R = -5391.33 N_y - 418 \ddot{\psi} + 2702 - 7.08 N_x + 15.55 N_z + \ddot{\theta} - 11.98 \le 0$$

ESTIMATE $\bar{R}^t_R$ (F2)

$$\bar{R}^t_R = -468.75 N_x - 5391.33 N_y + 1028.75 N_z + 66.17 \ddot{\theta} - 418 \ddot{\psi} + 338 + 2702$$

$$\bar{R}^t_R = -5391.33 N_y - 418 \ddot{\psi} + 2702 - 7.08 N_x + 15.55 N_z + \ddot{\theta} + 5.11 \le 0$$

CORNER PTS $\bar{R}^t_R = R_{MAX} = 10128$

AT $N_z = 4$ (F2 CRITICAL)

$N_x = -1.5,\ \ddot{\theta} = 4.0,\ \ddot{\psi} = -2$

$-5391.33 N_y = 10{,}128 - 8959 \quad N_y = -0.22$

AT $N_y = 0$

$N_z = 10128 - \cancel{4844} / 1028.75 = 5.14$

$N_{z\,max}$, $\cancel{N_{y}}$ (F2 CRITICAL)

$N_x = -1.5,\ \ddot{\theta} = 4.0,\ \ddot{\psi} = -2$

$N_z = [(7.08)(-1.5) - 4 - 5.11] / 15.55$
$= -1.27$

$N_y = 10128 - 3598 / -5391.33$

$N_y = -1.22$

<u>F1A AIRLOADS EQUIVALENT TO LOAD FACTORS</u>

$AN_x = 404/1569 = 0.258$

$AN_y = -517/1569 = -0.330$

$AN_z = -0.248$

$A\ddot{\theta} = -6.343$

$A\ddot{\psi} = (-25822)(386)/(1182667) = -8.428$

$\overline{R}^{+}_{R(F1A)} = (-5391.33)(-0.330) + (-418)(-8.428) = 5302$

$(-468.75)(0.258) + (1028.75)(-0.248) + (66.17)(-6.343)$

$= -796$ (XZ PLANE LOAD FOR F1A)

<u>F2A AIRLOADS EQUIVALENT TO LOAD FACTORS</u>

$AN_x = 400/1569 = 0.255$

$AN_y = -0.330$

$AN_z = 0.166$

$A\ddot{\theta} = 4.300$

$A\ddot{\psi} = -8.428$

$(-468.75)(0.255) + (1028.75)(0.166) + (66.17)(4.300)$

$= 336$ (XZ PLANE LOAD FOR F2A

$\overline{R}^{+}_{R(F2A)} = 336 + 5302 = 5638$

<u>ENVELOPE ESTIMATE - WITH YAW SHIFT</u>
<u>F1A & F2A AIRLOADS</u>

<u>CORNER PTS</u>

$N_y = 10128 - 11893/-5391.33 = 0.33$, $N_z = 4.0$,
$N_x = -1.5$, $\ddot{\theta} = 4.0$, $\ddot{\psi} = -2$ (F2A)

$N_z = 10128 - 7778/1028.75 = 2.28$, $N_y = 0$,
$N_x = -1.5$ $\ddot{\theta} = 4.0$, $\ddot{\psi} = -2$ (F2A)

$N_z = [(7.08)(-1.5) - 4 - 5.08]/15.55 = -1.27$

$N_y = 10128 - 6474/-5391.33 = -0.678$

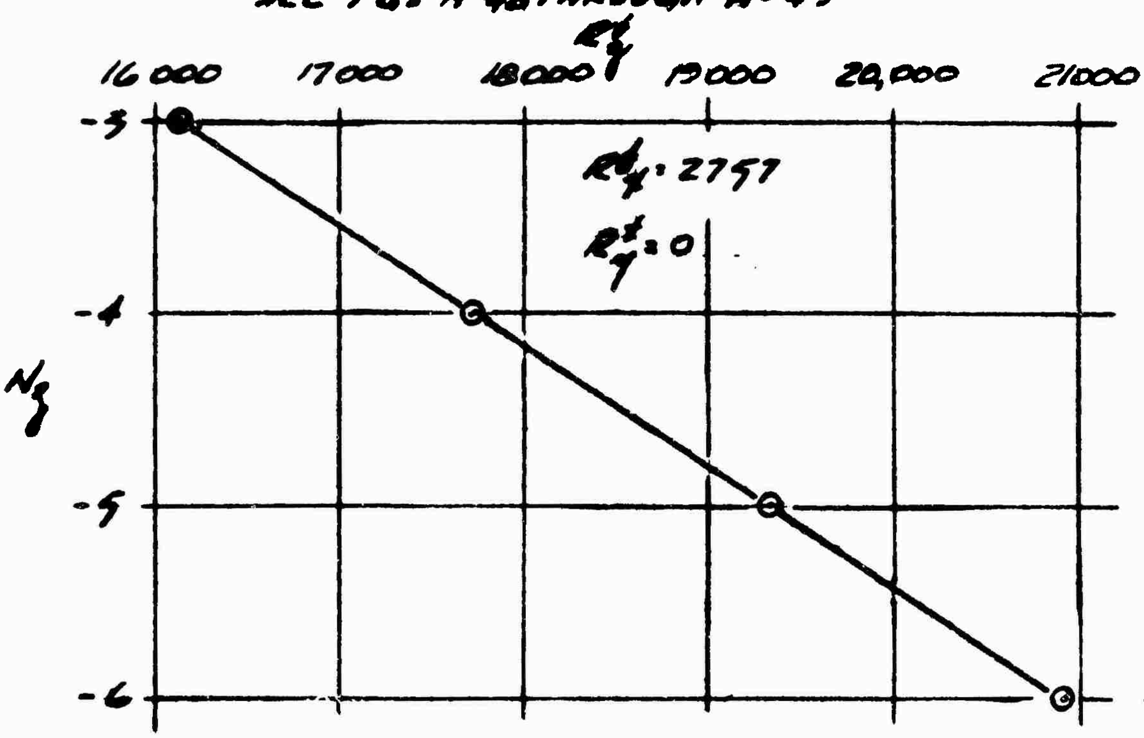
LOADS TEST - SEE PGS A-46 THROUGH A-47

$N_{z_{min}}, N_{y_{max}}$ (FLA CRITICAL)

BY LOADS TEST - $N_x = 1.5$; $N_y = -0.7$; $\ddot{\theta} = -4.0$

$\ddot{\psi} = -2.0$; $N_z = -3.0, -4.0, -5.0, -6.0$.

SEE PGS A-48 THROUGH A-49



$a + b N_z = c$

$a - 3b = 16121$

$a - 6b = 20906$

$b = (-20906 + 16121)/3 = -1595$

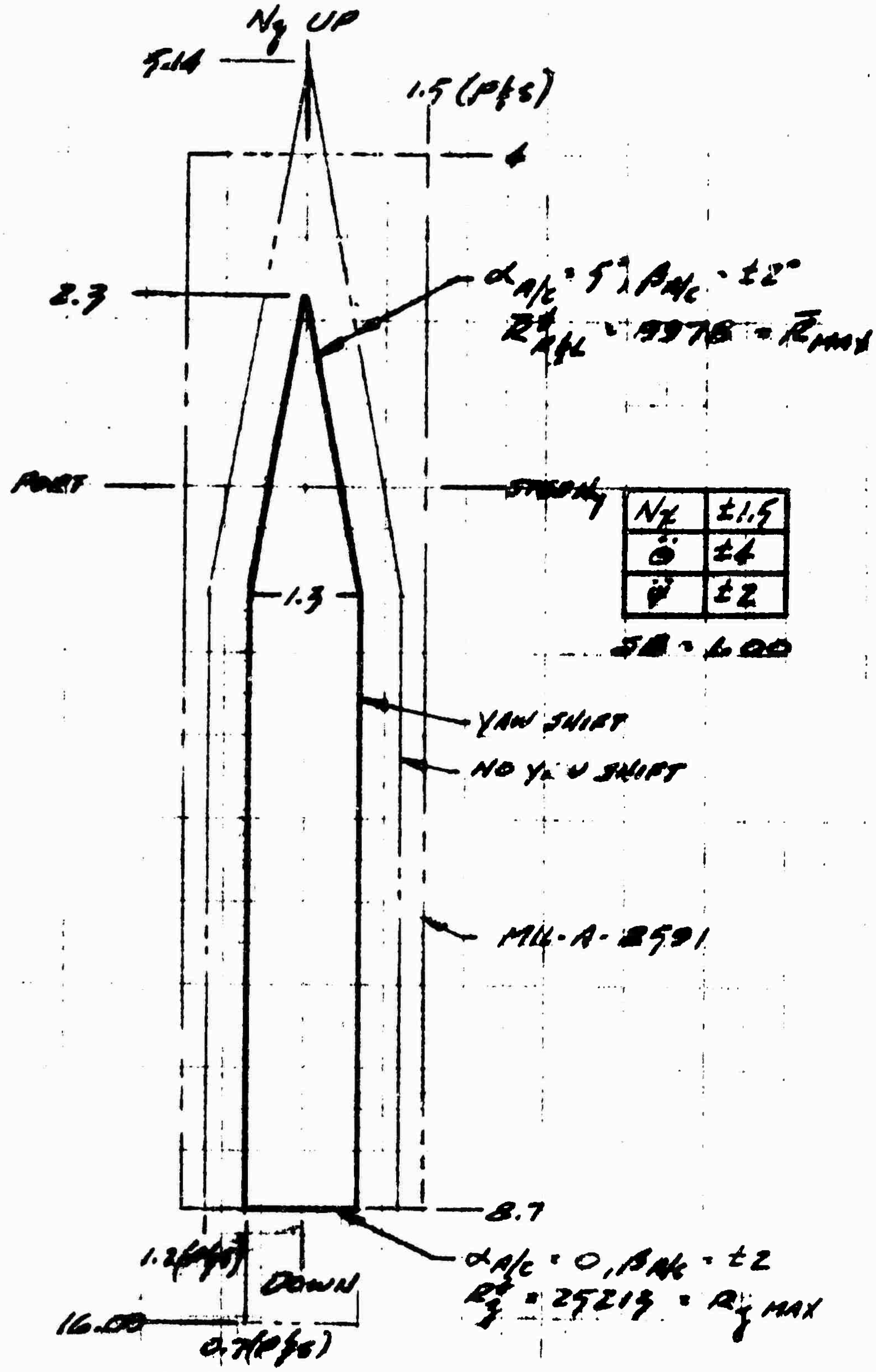
$a = 16121 - (1595)(3) = 11336$

$N_{z_{min}} = (R^t_{z_{max}} - 11336)/-1595$

$R^t_{z_{max}} = 37000 \quad N_{z_{min}} = -16.09$

LOADS TEST - SEE PG. A-50.

4. FERRY FLIGHT ENVELOPE - SEE FIGURE A-12 (SF = 1.00)



N_x	±1.5
$\ddot{\theta}$	±4
$\ddot{\psi}$	±2

FIGURE A-12 FERRY FLIGHT ENVELOPE - A-4 A/C
& RACK MOUNT, RMU-8/A (S/N 022)
LIMIT LOADS AT 0.8M @ S.L.

5. SWAY BRACE LIMIT REQUIRED FOR MIL-A-8591 COMPLIANCE FOR FERRY FLIGHT (SB = 1.00)

$N_x = -1.5$; $N_y = -1.5$; $N_z = 4.00$; $\ddot{\theta} = 4.00$ $\ddot{\psi} = -2.00$

$R_R^t = R_{MAX} = 11893 + (-1.5)(-5391.33) = 19,980$

6. LUG LIMIT REQUIRED FOR MIL-A-8591 COMPLIANCE FOR FERRY FLIGHT (SB = 1.00)

$R_z^t = R_{z\,MAX} = 11396 - 1599\,N_z$

$N_x = 1.5$; $N_y = -1.5$; $N_z = -8.7$; $\ddot{\theta} = -4.00$ $\ddot{\psi} = -2.00$

$R_z^t = R_{z\,MAX} = 25219$

7. LOADING CONDITION – ARREST (FIELD ONLY, SB = 1.00)

REDUCED PITCH & YAW ACCELERATION

$N_z = \pm 2.0$; $\ddot{\theta} = \pm 6$; $\ddot{\psi} = \pm 3$; $\bar{R}_{MAX} = 10,128$

$R_{z\,MAX}^t = 37,000$, $R_{x\,MAX}$ NOT CRITICAL

NO AIRLOAD ; $\ddot{\theta} = 6$; $\ddot{\psi} = -3$

$\bar{R}_{MAX} = \bar{R}_R^b = 5391.33\,N_y + 1254,$

$-7.08\,N_x + 15.55\,N_z + 6 \leq 0$

$N_y = \pm\, 8874 / 5391.33 = \pm 1.646$

$\bar{R}_{MAX} = \bar{R}_R^t = 468.75\,N_x + 1028.75\,N_z + 1691,$

$N_y = 0$, $-7.08\,N_x + 15.55\,N_z + 6 > 0$

$N_x = (8874 - 1028.75\,N_z) / -468.75$

N_z	-2	0	2
$N_{x\,N_y = 1.646}$	-3.55	0.85	5.24
$N_{x\,N_y = 0}$	-23.32	-18.93	-14.54

LOADS TEST PG A-51 & A-52

8. FIELD ARRESTMENT ENVELOPE - SEE FIGURE A-15 (SB:1.00)

9. LOADING CONDITION - FLIGHT - TOW

EQUIVALENT LIMIT TOW @ 10,000 FT.

$q = 640\#/ft^2$

$M = 0.78$

TAS = 500 KNOTS

A/C IN LEFT TURN $N_z = 3$

$r = 7840$ $\pi C_d = 0.0132$

$l_m = 2000$ $C_{D_0} = 1.66$

SEE PG A-53 FOR ORBITING PROGRAM OUTPUT
PROBE FIGHTER (FIGHT) & 0.182 IN-DIA TOWLINE

$T_m = 4065$ LBS

$N_z' = 1/\cos[1.249 \times 360/2\pi] = 3.11$ TARGET CONDITIONS

$r' = 8156$

$V' = 520$ KN TAS

$\Delta l = 100$

$\Delta r = 2$

$\Delta z = 6$ $\Delta r^2 + \Delta z^2 = 40$

$P_z' = 5.06$

$P_y' = 3.79$

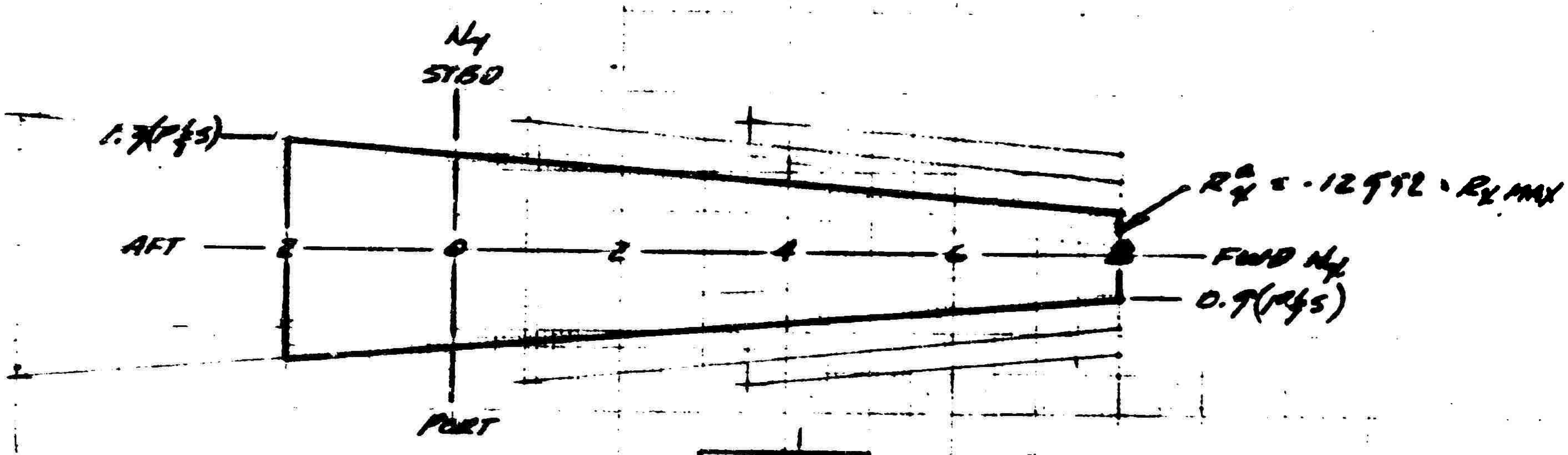
$RP_{xz}' = 99.93$

$P_x' = 99.80$

$\rho_x' = 0.998$ $F_x = 4057$

$\rho_y' = 0.038$ $F_y = 155$

$\rho_z' = 0.051$ $F_z = -208$ (MIL-A-8591)



Ny	±2
$\ddot{\theta}$	±6
$\ddot{\psi}$	±3

FIGURE A-13 FIELD ARRESTMENT ENVELOPE - A4 A/C
& RACK MOUNT RMU-8/A S/N 022
LIMIT LOADS W/ REEL-LCHR WT = 1983 LBS.

A/C NOSE UP & YAWED RIGHT

$\alpha_{A/C} = 8°, \beta_{A/C} = -5°, \beta_s = -5°$

$TP_x = 4049$

$TP_y = -58$

$TP_z = 359$

$TM_x = (-58)(-3.6) = 209$

$TM_y = (359)(64.6 - 123.6) + (4049)(-3.6) = -35758$

$TM_z = (-58)(64.6 - 123.6) = 3,422$

LOADS PROGRAM

MX = 209

ALOADX = 4049 + 275 = 4324

ALOADY = -58 - 419 = -477

ALOADZ = 359 + 419 = 778

XMM = -35758 + 20,644 = -15114

XMN = 3422 - 20644 = -17222

$N_z = -3$

SEE WORST CASE PG A-54

A/C NOSE UP & YAWED LEFT

$\alpha_{A/C} = 8°, \beta_{A/C} = 3°, \beta_s = 5°$

$TP_x = 4033$	ALOADX = 4308
$TP_y = 368$	ALOADY = 787
$TP_z = 359$	ALOADZ = 778
$TM_x = -1325$	MX = -1325
$TM_y = -35700$	XMM = -15056
$TM_z = -21712$	XMN = -1068
	$N_z = -3$

SEE WORST CASE PG A-55

A/C LEVEL & YAWED RIGHT

$\alpha_{A/C} = 0°, \beta_{A/C} = -3°, \beta_S = -5°$

TP_X = 4060	ALOADX = 4329
TP_Y = -98	ALOADY = -477
TP_Z = -208	ALOADZ = -463
TM_X = 209	MX = 209
TM_Y = -2344	XMM = -15165
TM_Z = 3422	XMN = -17222
	N_Z = -3

SEE WORST CASE PG A-56

A/C LEVEL & YAWED LEFT

$\alpha_{A/C} = 0°, \beta_{A/C} = 3°, \beta_S = 5°$

TP_X = 4044	ALOADX = 4313
TP_Y = 368	ALOADY = 787
TP_Z = -208	ALOADZ = -463
TM_X = -1325	MX = -1325
TM_Y = -2286	XMM = -15107
TM_Z = -21712	XMN = -1068
	N_Z = -3

SEE WORST CASE PG A-57

STORE LEVEL & NO YAW

$\alpha_{A/C} = 3°, \beta_{A/C} = 0 = \beta_S$ $\quad AP_X = 255$

TP_X = 4063	ALOADX = 4318
TP_Y = 155	ALOADY = 155
TP_Z = 5	ALOADZ = 5
TM_X = -558	MX = -558
TM_Y = -14922	XMM = -14922
TM_Z = -9145	XMN = -9145

SEE WORST CASE PG A-58

10. <u>CRITICAL LOADING CONDITION - FLIGHT - TOW</u>

SEE FIGURE A-16

11. <u>LOADING CONDITION - FLIGHT - TOW</u>

(LESS THAN LIMIT AIRSPEED - TOWLINE FAILURE)

<u>COMPONENT LOADS</u> & <u>LOAD CONTRIBUTION</u>

(SEE TABLE V AND PGS A-59 THROUGH A-71

<u>A/C LEVEL</u> & <u>NO YAW</u>

DATA FROM TABLE A-1

$$\bar{R}^{b}_{R(N_x)} + \bar{R}^{b}_{R(N_z)} + \bar{R}^{b}_{R(\ddot{\theta})} + \bar{R}^{b}_{R(AN_z)} + \bar{R}^{b}_{R(A\ddot{\theta})} \leq 0$$

$$\bar{R}^{b}_{R} = \bar{R}^{b}_{R(N_y)} + \bar{R}^{b}_{R(\ddot{\psi})} + \bar{R}^{b}_{R(AN_y)} + \bar{R}^{b}_{R(A\ddot{\psi})} + \bar{R}^{b}_{R(AM_x)}$$

$AP_y = 0 = AM_z$, $\bar{R}^{b}_{R}$ (TOWLINE ~~[illegible]~~); $N_y = 0 = \ddot{\psi}$ ($\bar{R}^{b}_{R(TU)}$))

$TP_y = (6000)(P_y')$

$TM_x = (-3.6)(TP_y)$

$TM_z = (X_{c.g} - 123.6)(TP_y)$

<u>$\ell = 1000$ FT</u>

$P_y'(MAX) = 0.0559$

$TP_y = 335.4$

$TM_x = -1207.44$

$TM_z = -19553.82$

$AN_y = 0.214$

$AM_x = TM_x = M_x$

$A\ddot{\psi} = -6.382$

$\bar{R}^{b}_{R(TU)} = (-5391.33)(0.214) + (-418)(-6.382) + (-1207.44)(0.358)$

$= 1202.41$

SEE TABLE V FOR SUMMARY

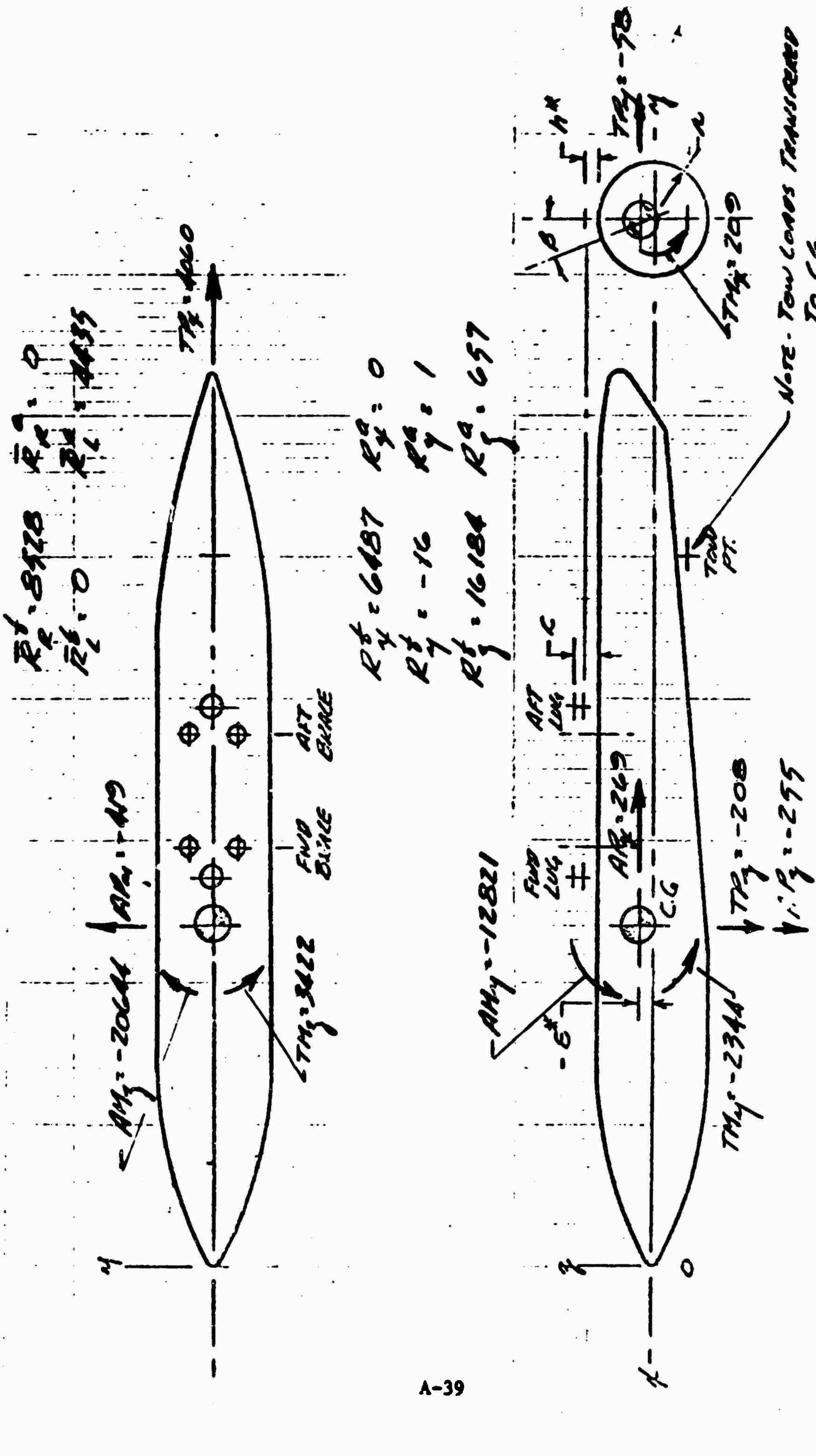


FIGURE A-14 TOW FLIGHT CONDITIONS A/C LEVEL & YAWED RIGHT

DATA SHEET
4ND-NADC-3960/11

TABLE II

CONTRIBUTION OF COMPONENT LOADS VS. TOWLINE LENGTH FOR $\bar{R}^t_R$ (R_{max})

l	<2000	2000	6000	10000	X FACTOR
$X_{C.G.}$	65.3	64.6	62.7	59.7	
$\dot{N}_x$	-468.75	-430.	-352.25	-274.25	N_x
N_y	-5391.55	-5143.33	-4520.	-3894.67	N_y
N_z	1028.75	965.	838.75	712.25	N_z
$\ddot{\theta}$	66.17	64.75	60.42	55.5	$\ddot{\theta}$
$\ddot{\psi}$	-418.	-408.67	-381.5	-350.	$\ddot{\psi}$
M_x	0.258	0.265	0.284	0.314	M_x
AN_x	1/1569	1/1439	1/1179	1/918	AN_x/TN_x
AN_y	1/1569	1/1439	1/1159	1/918	AN_y/TN_y
AN_z	1/1569	1/1439	1/1179	1/918	AN_z/TN_z
$A\ddot{\theta}$	1/3080	1/3011	1/2812	1/2581	AM_y/TM_y
$A\ddot{\psi}$	1/3064	1/2996	1/2797	1/2565	AM_z/TM_z
AM_x	1	1	1	1	TM_x

l	1000	2000	6000	10,000
$\dot{N}_y(max)$	0.0559	0.1210	0.1699	0.1662
TN_y	339.4	726.0	1019.4	997.2
TM_x	-1207.44	-2613.6	-3669.84	-3157.92
TM_z	-1955382	-42834.	-6208146	-5605308
AN_y	0.216	0.505	0.865	0.956
AM_x	$TM_x \cdot M_x$	—	—	—
$A\ddot{\psi}$	-6.382	-14.297	-22.196	-21.859
$\bar{R}^t_R(TU)$	1202.41	2552.77	3515.74	2933.66

PLATE NO. 13038

WORST CASE IS TOWING [illegible] WITH [illegible] FIGHTER IN 2G [illegible] TURN AT MACH 0.5 (292 KNCAS), 10,000 FT ALT.

$q = 255$ PSF (TABLE A-1 FOR LOAD DATA)

USE T1 CONDITIONS (TABLE A-III) ADJUSTED FOR CG. @ 62.7 ($X_m(\beta) = 0.403$)

$X_m - X_{cp}$ (STORE, β) $= 0.295 + (0.415 - 0.403) = 0.307$

$X_m - X_{cp}$ (PV, β) $= 0.348 + (0.415 - 0.403) = 0.360$

$C_D = 0.188$

$C_{N_z} = C_{N_y} = -0.104 + (-0.079) = -0.183$

$C_{M_z} = C_{M_y} = [(-0.104)(0.307) + (-0.079)(0.360)] = -0.060$

$AP_x = 105$

$AF_z = AF_y = -102$

$AM_z = AM_y = -5195$

A/C LEVEL & YAWED RIGHT

$\alpha_{A/C} = 0°, \beta_{A/C} = -3, \beta_s = -5°$

$TP_x = [(6000)(0.9760)(\cos 0°)(\cos -3°) - (6000)(0.1363)(\sin 0°)(\cos -3°) - (6000)(0.1699)(\sin -3°)]$

$= 5901$

$TP_y = [(6000)(0.1699)(\cos -3°) + (6000)(0.9760)(\sin -3°)]$

$= 712$

$TP_z = [(6000)(0.1363)(\cos 0°) + (6000)(0.9760)(\sin 0°)]$

$= 818$

$TM_y = (818)(62.7 - 123.6) + (5901)(-3.6) = -71060$

$TM_z = (712)(62.7 - 123.6) = -43361$

$TM_x = (712)(-3.6) = -2563$

TOTAL AIRLOAD

ALOADX = 5901 + 105 = 6006

ALOADY = 712 - 102 = 610

ALOADZ = 818 - 102 = 716

MX = -2563

XMM = -71060 - 5195 = -76255

XMN = -43361 - 5195 = -48556

$N_x = 1.5$, $N_y = -0.7$, $N_z = -2.0$, $\ddot{\theta} = -4.0$, $\ddot{\psi} = -2.0$

LOADS TEST - SEE PAGE A-72

12 REACTIONS AT RACK MOUNTING BOLTS

SEE APPENDIX C

COMPONENT LOADS

```
PROGRAM     LOONG                          CDC 6600 FTN V4.0-P336 OPT=1  05/06/74  14.13.47.     PAGE    1

                PROGRAM LOONG (INPUT,OUTPUT,TAPE5=OUTPUT)
                REAL MY,MZ,MX
                READ 1001,FL,AL,FSB,ASB
                WRITE(6,99)
           C
           C    CALCULACTIONS OF MOMENT ARMS
           C
                CG=65.3
                XLA=AL-CG
                XLF=CG-FL
                XLBA=ASB-CG
                XLBF=CG-FSB
                BETA=21.5/57.296
           C    LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
           C
                SB=1.00
                E1=0.
                CX=1.60
                H=1.20
                R=12.3
                MX=0.
                XY=1186667./386.
                XZ=1182667./386.
                WT=1569.
           C
           C
                ALOADX=0.0
                ALOADY=0.0
                ALOADZ=0.0
                XMM=0.0
                XMN=0.0
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	-4.00	0.00	0.00	0.00	0.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	6979.	3750.	3750.	0.	0.
(Y)	0.	0.				
(X)	0.	-12552.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	4.00	0.00	0.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	1381.	4115.	4115.	0.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	-1.50	0.00	0.00	0.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	6622.	2639.	0.	8187.	1766.	0.
(Y)	0.	0.				
(X)	0.	0.				

2.

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	0.00	12.00	0.00

LOADING POINTS

	LUG		FOWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	1478.	794.	794.	0.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.6[illegible]	0.00	0.00	-6.00

LOADING POINTS

	LUG		FOWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	2333.	2333.	0.	2508.	2508.	0.
(Y)	0.	0.				
(X)	0.	0.				

PROGRAM LODNG   CDC 6600 FTN V3.0-P355 OPT=1 06/04/74 08.57.59.   PAGE 1

```
      PROGRAM LODNG (INPUT,OUTPUT,TAPE6=OUTPUT)
      REAL MY,MZ,MX
      READ 1001,FL,AL,FSB,ASB
      WRITE(6,99)
C
C     CALCULACTIONS OF MOMENT ARMS
C
      CG=65.3
      XLA=AL-CG
      XLF=CG-FL
      XLBA=ASB-CG
      XLBF=CG-FSB
      BETA=21.5/57.296
C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
C
      SB=1.00
      E1=0.
      CX=1.50
      H=1.20
      R=12.3
      MX=0.
      XY=1138667./386.
      XZ=1142667./386.
      WT=1569.
C
C
      ALOADX=408.
      ALOADY=-517.
      ALOADZ=261.
      XMM=13242.
      XMN=-25522.
   10 READ 1002,A,B,C,D,E,L
      PX=A*WT+ALOADX
      PY=B*WT+ALOADY
      PZ=C*WT+ALOADZ
      MY=D*XY+XMM
      MZ=E*XZ+XMN
      IF(L.NE.0)GO TO 601
C
C
C     TRIAL LUG REACTIONS
C
      ARM=R+H-E1
      VBF=((PY*(R+H)-MX)*XLBA+SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
      VBA=((PY*(R+H)-MX)*XLBF-SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
      VBF=ABS(VBF)
      VBA=ABS(VBA)
      RFPZ=(PX*(R+CX)-PZ*XLA-MY+VBF*(XLA+XLBF)-VBA*(XLBA-XLA))/(XLA+XLF)
      RAPZ=(MY-PX*(R+CX)-PZ*XLF+VBA*(XLF+XLBA)-VBF*(XLBF-XLF))/(XLA+XLF)
C     TESTING FOR CASE TO BE USED
C
      IF(RFPZ.GE.0.0.AND.RAPZ.GE.0.0) GO TO 21
      IF(RFPZ.GE.0.0.AND.RAPZ.LT.0.0) GO TO 27
      IF(RFPZ.LT.0.0.AND.RAPZ.GE.0.0) GO TO 38
      IF(RFPZ.LT.0.0.AND.RAPZ.LT.0.0) GO TO 49
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>FERRY

	NX	NY	NZ	THETA	PSI
LOAD FACTORS	-1.50	0.00	2.30	4.00	-2.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FOWARD SWAY BRACE LEFT	FOWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	0.	6493.	117.	5274.	4747.	0.
(Y)	0.	0.				
(X)	0.	-1953.				

LOAD ANALYSIS MIL-A-8591 F

LOADING CONDITION FLIGHT>FERRY

	NX	NY	NZ	THETA	PSI
LOAD FACTORS	-1.50	-.70	-1.30	4.00	-2.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FOWARD SWAY BRACE LEFT	FOWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	8532.	7594.	0.	9978.	5571.	0.
(Y)	0.	0.				
(X)	-1953.	0.				

TEST FOR R_3^2 ...

```
PROGRAM     LOUNG                                CDC 6600 FTN V3.0-P336 OPT=1  06/06/74  08.33.53.      PAGE    1

                   PROGRAM LOUNG (INPUT,OUTPUT,TAPE6=OUTPUT)
                   REAL NY,NZ,NX
                   READ 1001,FL,AL,FSB,ASB
                   WRITE(6,99)
             C
             C     CALCULATIONS OF MOMENT ARMS
             C
                   CG=65.3
                   XLA=AL-CG
                   XLF=CG-FL
                   XLBA=ASB-CG
                   XLBF=CG-FSB
                   BETA=21.5/57.296
             C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
             C
                   SB=1.00
                   E1=0.
                   CX=1.60
                   H=1.20
                   R=12.3
                   NX=0.
                   XY=1144667./386.
                   XZ=1162667./386.
                   WT=1569.
             C
             C
                   ALOADX=404.
                   ALOADY=-517.
                   ALOADZ=-389.
                   XMM=-19532.
                   XMN=-25622.
                10 READ 1102,A,B,C,D,E,L
```

LOADING CONDITION FLIGHT>FERRY

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	1.50	-.70	-6.00	-4.00	-2.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	20906.	3364.	0.	9974.	5571.	0.
(Y)	0.	0.				
(X)	2757.	0.				

6

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>FERRY

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	1.50	-.70	-3.00	-4.00	-2.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	16121.	3442.	0.	9978.	5571.	0.
(Y)	0.	0.				
(X)	2757.	0.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>FERRY

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	1.50	-.70	-4.00	-4.00	-2.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	17716.	3416.	0.	9978.	5571.	0.
(Y)	0.	0.				
(X)	2757.	0.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>FERRY

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	1.50	-.70	-5.00	-4.00	-2.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	19311.	3390.	0.	9978.	5571.	0.
(Y)	0.	0.				
(X)	2757.	0.				

LOAD ANALYSIS MIL-A-8591 E

PRINT-FERRY P10

```
PROGRAM     LOUNG                              CDC 6600 FTN V3.0-P336 OPT=1  06/06/74  00.50.45.     PAGE    1

            PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
            REAL NY,NZ,NX
            READ 1001,FL,AL,FSB,ASB
            WRITE(6,99)
      C
      C     CALCULACTIONS OF MOMENT ARMS
      C
            CG=65.3
            XLA=AL-CG
            XLF=CG-FL
            XLBA=ASB-CG
            XLBF=CG-FSB
            BETA=21.5/57.296
      C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
      C
            S9=1.00
            F1=0.
            CY=1.50
            H=1.29
            P=12.3
            NX=0.
            YY=1189667./386.
            YZ=1182667./386.
            WT=1569.
      C
      C
            ALOADX=404.
            ALOADY=-517.
            ALOADZ=-389.
            YMM=-19532.
            XMN=-25822.
         10 READ 1002,A,B,C,D,E,L
            PX=A*WT+ALOADX
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>FERRY

	NX	NY	NZ	THETA	PSI
LOAD FACTORS	1.50	-.70	-0.70	-4.30	-2.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FOWARD SWAY BRACE LEFT	FOWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	25213.	3293.	0.	9978.	5571.	0.
(Y)	0.	0.				
(X)	2757.	0.				

8

```
PROGRAM     LOONG                                   CDC 6600 FTN V3.0-P336 OPT=1  06/04/74  09.47.18.     PAGE    1

                PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
                REAL MY,MZ,MX
                READ 1001,FL,AL,FSB,ASB
                WRITE(6,99)
          C
          C     CALCULATIONS OF MOMENT ARMS
          C
                CG=65.8
                XLA=AL-CG
                XLF=CG-FL
                XLBA=ASB-CG
                XLBF=CG-FSB
                BETA=21.5/57.296
          C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
          C
                SB=1.00
                S1=0.
                CX=1.60
                H=1.20
                R=12.3
                XY=1186667./386.
                XZ=1182567./386.
                WT=1569.
          C
          C
                ALOADX=0.0
                ALOADY=0.0
                ALOADZ=0.0
                MX=0.
                XMN=0.0
                XMN=0.0
             10 READ 1002,A,B,C,D,E,L
                PX=A*WT+ALOADX
                PY=B*WT+ALOADY
                PZ=C*WT+ALOADZ
                MY=D*XY+XMN
                MZ=E*XZ+XMN
                IF(L.NE.0)GO TO 691
          C
          C
          C     TRIAL LDG REACTIONS
          C
                ARM=R+H-C1
                VBE=((PY*(R+H)-MX)*XLBA+SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
                VBB=((PY*(R+H)-MX)*XLBF-SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
                VBF=ABS(VBE)
                VBA=ABS(VBB)
                RFPZ=(PX*(R+CX)-PZ*XLA-MY+VBF*(XLA+XLBF)-VBA*(XLBA-XLA))/(XLA+XLF)
                RAPZ=(MY-PX*(R+CX)-PZ*XLF+VBA*(XLF+XLBA)-VBF*(XLBF-XLF))/(XLA+XLF)
          C     TESTING FOR CASE TO BE USED
          C
                IF(RFPZ.GE.0.0.AND.RAPZ.GE.0.0) GO TO 21
                IF(RFPZ.GE.0.0.AND.RAPZ.LT.0.0) GO TO 27
                IF(RFPZ.LT.0.0.AND.RAPZ.GE.0.0) GO TO 38
                IF(RFPZ.LT.0.0.AND.RAPZ.LT.0.0) GO TO 49
```

9.

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION ARREST>NO TGT

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	2.00	-1.30	2.00	6.00	-3.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	4554.	2668.	0.	8350.	2734.	0.
(Y)	0.	0.				
(X)	3138.	0.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION ARREST>NO TGT

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	-8.00	-.50	2.00	6.00	-3.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	9780.	4023.	8012.	1843.	0.
(Y)	0.	0.				
(X)	0.	-12552.				

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CDC 6600 FTN V3.0-P336 OPT=1 05/16/74 14.43.39. PAGE 1

PROGRAM ORBITNG

```
      PROGRAM ORBITNG(INPUT,OUTPUT)
C     TOWLINE STEADY STATE CONFIGURATION----TOWPLANE IN LEFT TURN
C V = TOWPLANE TRUE AIRSPEED , KNOTS
C RPL = TOWPLANE TURN RADIUS, ORBIT CENTER, LEFT TURN, FT
C ZPL = TOWPLANE DENSITY ALTITUDE FT
C AMG = TARGET WEIGHT , LB.
C ABASE = TARGET BASE AREA , SQ FT
C CDDRDG = TARGET DRAG COEFFICIENT
C AMUG = TOWLINE WEIGHT, LB/FT
C D = TOWLINE DIAMETER, FT
C AL = TOWLINE LENGHT , FT
C PICF = TOWLINE SKIN FRICTION COEFFICIENT
C CD = TOWLINE DRAG COEFFICIENT
C      XCG = DISTANCE FROM TOWPOINT TO TARGET CENTER OF GRAVITY, FT
C      XCP = DISTANCE FROM TOWPOINT TO TARGET CENTER OF PRESSURE ,FT
C      ZCL = DISTANCE FROM TOWPOINT TO TARGET CENTERLINE, FT
C      THETA = TOWLINE TRAIL ANGLE AT TARGET, XZ PLANE, RADIANS
C      PHI = TARGET BANK ANGLE, RADIANS
C     CONSTANT
      G = 32.17 $PI = 3.1416
      XCG = 0.750 $XCP = 4.530 $ZCL = 1.500
```

V(KNOTS)= .5000E+03 RPL= .7640E+04 ZPL= .1000E+05 RZD= .8156E+04 ZZD= .9800E+04
AMG= .5000E+03 ABASE= .9075E+02 CDDRDG= .4500E-01
AMUG= .6567E-01 D= .1517E-01 AL= .2000E+04 DJS= .1000E+03 PICF= .1320E-01 CD= .1660E+01
PHI= .1243E+01 THETA= .6530E+00 TDRDG= .3743E+04

S	R	Z	TM	T	RP	ZP	RTMP
0.	.8156E+04	.9800E+04	0.	.3743E+04	-.5753E+00	.1954E+00	.7942E+00
.2000E+01	.8155E+04	.9800E+04	.1950E-03	.3743E+04	-.5727E+00	.1945E+00	.7964E+00
.7000E+01	.8152E+04	.9801E+04	.6851E-03	.3744E+04	-.5660E+00	.1924E+00	.8017E+00
.2000E+02	.8145E+04	.9804E+04	.1974E-02	.3747E+04	-.5494E+00	.1871E+00	.8144E+00
.4000E+02	.8134E+04	.9807E+04	.3937E-02	.3752E+04	-.5252E+00	.1794E+00	.8319E+00
.6000E+02	.8123E+04	.9811E+04	.6062E-02	.3756E+04	-.5026E+00	.1722E+00	.8472E+00
.8000E+02	.8114E+04	.9814E+04	.8100E-02	.3761E+04	-.4814E+00	.1656E+00	.8607E+00
.1000E+03	.8104E+04	.9816E+04	.1030E-01	.3765E+04	-.4617E+00	.1594E+00	.8726E+00
.1300E+03	.8093E+04	.9822E+04	.1356E-01	.3771E+04	-.4344E+00	.1510E+00	.8880E+00
.1600E+03	.8076E+04	.9827E+04	.1666E-01	.3779E+04	-.4097E+00	.1434E+00	.9009E+00
.1900E+03	.8066E+04	.9831E+04	.2025E-01	.3786E+04	-.3872E+00	.1365E+00	.9118E+00
.2200E+03	.8055E+04	.9835E+04	.2366E-01	.3730E+04	-.3666E+00	.1303E+00	.9212E+00
.2600E+03	.8041E+04	.9840E+04	.2827E-01	.3799E+04	-.3419E+00	.1230E+00	.9316E+00
.3000E+03	.8027E+04	.9845E+04	.3293E-01	.3805E+04	-.3194E+00	.1166E+00	.9403E+00
.3400E+03	.8015E+04	.9849E+04	.3764E-01	.3813E+04	-.3000E+00	.1109E+00	.9475E+00
.3800E+03	.8003E+04	.9854E+04	.4233E-01	.3820E+04	-.2828E+00	.1058E+00	.9536E+00
.4400E+03	.7937E+04	.9860E+04	.4957E-01	.3831E+04	-.2581E+00	.9923E-01	.9610E+00
.5000E+03	.7972E+04	.9866E+04	.5601E-01	.3842E+04	-.2371E+00	.9366E-01	.9670E+00
.6000E+03	.7955E+04	.9875E+04	.6901E-01	.3859E+04	-.2074E+00	.8615E-01	.9745E+00
.7000E+03	.7931E+04	.9883E+04	.8134E-01	.3876E+04	-.1825E+00	.8029E-01	.9799E+00
.8000E+03	.7913E+04	.9891E+04	.9371E-01	.3892E+04	-.1613E+00	.7560E-01	.9840E+00
.9000E+03	.7896E+04	.9896E+04	.1062E+00	.3908E+04	-.1427E+00	.7197E-01	.9871E+00
.1000E+04	.7885E+04	.9905E+04	.1187E+00	.3924E+04	-.1263E+00	.6904E-01	.9896E+00
.1100E+04	.7873E+04	.9912E+04	.1313E+00	.3939E+04	-.1116E+00	.6670E-01	.9915E+00
.1200E+04	.7862E+04	.9913E+04	.1439E+00	.3954E+04	-.9816E-01	.6484E-01	.9931E+00
.1300E+04	.7853E+04	.9925E+04	.1565E+00	.3969E+04	-.8582E-01	.6335E-01	.9946E+00
.1400E+04	.7845E+04	.9931E+04	.1692E+00	.3983E+04	-.7435E-01	.6220E-01	.9953E+00
.1500E+04	.7836E+04	.9937E+04	.1819E+00	.3997E+04	-.6354E-01	.6142E-01	.9961E+00
.1600E+04	.7832E+04	.9943E+04	.1946E+00	.4011E+04	-.5333E-01	.6080E-01	.9967E+00
.1700E+04	.7826E+04	.9950E+04	.2074E+00	.4025E+04	-.4358E-01	.6037E-01	.9972E+00
.1800E+04	.7824E+04	.9956E+04	.2201E+00	.4039E+04	-.3421E-01	.6010E-01	.9970E+00
.1900E+04	.7821E+04	.9962E+04	.2324E+00	.4052E+04	-.2515E-01	.5994E-01	.9979E+00
.2000E+04	.7819E+04	.9968E+04	.2456E+00	.4065E+04	-.1637E-01	.5986E-01	.9981E+00

A/c ___ up & ___ ___

```
      PROGRAM     LOONG                          CDC 6600 FTN V3.0-P396 OPT=1  06/04/74  09.30.16.       PAGE    1

            PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
            REAL MY,MZ,MX
            READ 1001,FL,AL,FSA,ASA
            WRITE(6,99)
      C
      C     CALCULACTIONS OF MOMENT ARMS
      C
            CG=64.6
            XLA=AL-CG
            XLF=CG-FL
            XLSA=ASA-CG
            XLSF=CG-FSA
            BETA=21.5/57.296
      C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
      C
            S9=1.30
            C1=0.
            CX=1.50
            Y=1.29
            Z=12.3
            MX=200.
            XY=1152313./386.
            XZ=1156313./386.
            WT=1489.
      C
      C
            ALOADX=4326.
            ALOADY=-477.
            ALOADZ=778.
            XMM=-15114.
            XMN=-17222.
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>TOW

LOAD FACTORS	NX	NY	NZ	THETA	PST
	1.50	-.70	-3.00	-4.00	-2.00

LOADING POINTS

LUG

	FORWARD	AFT
(Z)	1488?.	711.
(Y)	-16.	1.
(X)	6482.	0.

FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
0.	852?.	4475.	0.

LOAD ANALYSIS MIL-A-8591 E

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A/c data as of Yankee Aft

```
PROGRAM    LODNG                                   CDC 6600 FTN V3.0-P336 OPT=1  06/06/74  09.36.36.     PAGE   1

                    PROGRAM LODNG (INPUT,OUTPUT,TAPE6=OUTPUT)
                    REAL MY,MZ,MX
                    READ 1001,FL,AL,FSB,ASB
                    WRITE(6,99)
              C
              C     CALCULACTIONS OF MOMENT ARMS
              C
                    CG=64.6
                    XLA=AL-CG
                    XLF=CG-FL
                    XLPA=ASB-CG
                    XLPF=CG-FSB
                    BETA=21.5/57.296
              C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
              C
                    S9=1.00
                    F1=0.
                    CY=1.50
                    H=1.20
                    R=12.3
                    XY=1162313./386.
                    XZ=1156313./386.
                    WT=1439.
              C
              C
                    ALOADX=6309.
                    ALOADY=787.
                    ALOADZ=778.
                    MX=-1325.
                    XMM=-15056.
                    XMN=-1058.
                 10 READ 1002,A,B,C,D,E,L
                    PX=A*WT+ALOADX
```

```
                                                   LOAD FACTORS     NX     NY     NZ    THETA   PSI
LOADING CONDITION  FLIGHT>TOW                                      1.50    .70  -3.00  -4.90   7.00

                          LOADING POINTS

        LUG                    FOWARD SWAY BRACE                     AFT SWAY BRACE

   FORWARD    AFT              LEFT          RIGHT                   LEFT         RIGHT

(Z) 13923.     0.              7436.           0.                    726.         2999.

(Y)   102.    -4.

(X)  6466.     0.

                          LOAD ANALYSIS MIL-A-8591 E
```

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A/C Level & Yawed Right

```
PROGRAM    LODNG                          CDC 6500 FTN V3.0-P336 OPT=1  05/06/74  11.49.12.      PAGE     1

                 PROGRAM LODNG (INPUT,OUTPUT,TAPE6=OUTPUT)
                 REAL MY,MZ,MX
                 READ 1001,FL,AL,FSB,ASB
                 WRITE(6,99)
           C
           C     CALCULACTIONS OF MOMENT ARMS
           C
                 CG=64.6
                 XLA=AL-CG
                 XLF=CG-FL
                 XLBA=ASB-CG
                 XLBF=CG-FSB
                 BETA=21.5/57.296
           C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
           C
                 SB=1.00
                 E1=0.
                 CX=1.60
                 H=1.20
                 R=12.3
                 XY=1162313./386.
                 XZ=1156313./386.
                 WT=1439.
           C
           C
                 ALOADX=4329.
                 ALOADY=-477.
                 ALOADZ=-463.
                 MX=209.
                 XMM=-15165.
                 XMN=-17222.
              10 READ 1002,A,B,C,D,E,.
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>TOW

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	1.50	-.70	-3.00	-4.00	-2.00

LOADING POINTS

	LUG		FOWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	16184.	657.	0.	8520.	4435.	0.
(Y)	-16.	1.				
(X)	6487.	0.				

LOAD ANALYSIS MIL-A-8591 E

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A/C LEVEL & YAWED LEFT

```
PROGRAM    LODNG                              CDC 6600 FTN V3.0-P336 OPT=1  06/04/74 08.10.13.     PAGE   1

                 PROGRAM LODNG (INPUT,OUTPUT,TAPE6=OUTPUT)
                 REAL MY,MZ,MX
                 READ 1001,FL,AL,FSB,ASB
                 WRITE(6,99)
           C
           C     CALCULACTIONS OF MOMENT ARMS
           C
                 CG=54.6
                 XLA=AL-CG
                 XLF=CG-FL
                 XLBA=ASB-CG
                 XLBF=CG-FSB
                 BETA=21.5/57.296
           C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
           C
                 S9=1.30
                 E1=0.
                 CX=1.60
                 H=1.20
                 R=12.3
                 XY=1152313./386.
                 XZ=1156313./386.
                 WT=1439.
           C
           C
                 ALOADX=4313.
                 ALOADY=787.
                 ALOADZ=-463.
                 MX=-1325.
                 XMM=-15107.
                 XMN=-1069.
              10 READ 1002,A,B,C,D,E,L
                 PX=A*WT+ALOADX
                 PY=B*WT+ALOADY
                 PZ=C*WT+ALOADZ
                 MY=D*XY+XMM
                 MZ=E*XZ+XMN
```

LOADING CONDITION FLIGHT>TOW

		NX	NY	NZ	THETA	PSI
	LOAD FACTORS	1.50	.70	-3.00	-4.00	2.00

LOADING POINTS

	LUG		FOWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	15228.	0.	7436.	0.	761.	3433.
(Y)	102.	-4.				
(X)	6471.	0.				

LOAD ANALYSIS MIL-A-8591 E

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```
PROGRAM     LODNG                                   CDC 6600 FTN V3.0-P336 OPT=1  06/04/74  09.45.16.     PAGE   1
                 PROGRAM LODNG (INPUT,OUTPUT,TAPE6=OUTPUT)
                 REAL MY,MZ,MX
                 READ 1001,FL,AL,FSB,ASB
                 WRITE(6,99)
            C
            C    CALCULACTIONS OF MOMENT ARMS
            C
                 CG=64.6
                 XLA=AL-CG
                 XLF=CG-FL
                 XLBA=ASB-CG
                 XLBF=CG-FSB
                 BETA=21.5/57.296
            C    LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
            C
                 SR=1.00
                 Z1=0.
                 TX=1.60
                 H=1.20
                 P=12.3
                 XY=1152313./386.
                 XZ=1156313./386.
                 WT=1639.
            C
            C
                 ALOADX=6316.
                 ALOADY=155.
                 ALOADZ=5.
                 XMM=-14922.
                 XMN=-9145.
                 MX=-558.
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION	FLIGHT>TOW	LOAD FACTORS	NX	NY	NZ	THETA	PSI
			1.50	-.70	-3.00	-4.00	-2.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	12893.	0.	0.	4964.	3505.	786.
(Y)	43.	-2.				
(X)	6476.	0.				

LOAD ANALYSIS MIL-A-8591 E

Stress levels of the year

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```
PROGRAM     LODNG                                   CDC 6600 FTN V3.0-P336 OPT=1  05/30/74  12.40.17.     PAGE    1

                  PROGRAM LODNG (INPUT,OUTPUT,TAPE6=OUTPUT)
                  REAL MY,MZ,MX
                  READ 1001,FL,AL,FSR,ASR
                  WRITE(6,99)
           C
           C      CALCULACTIONS OF MOMENT ARMS
           C
                  CG=65.3
                  XLA=AL-CG
                  XLF=CG-FL
                  XLBA=ASR-CG
                  XLBF=CG-FSR
                  BETA=21.5/57.296
           C      LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
           C
                  SR=1.00
                  S1=0.
                  RX=1.60
                  H=1.20
                  P=12.5
                  MX=1000.
                  XY=1198667./386.
                  XZ=1192667./386.
                  WT=1569.
           C
           C
                  ALOADX=0.0
                  ALOADY=0.0
                  ALOADZ=0.0
                  XMM=0.0
                  XMN=0.0
               10 READ 1002,A,B,C,D,E,F=1
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION ROLL ONLY					LOAD FACTORS	NX	NY	NZ	THETA	PSI
						0.00	0.00	0.00	0.00	0.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	208.	83.	0.	758.	56.	0.
(Y)	-75.	1.				
(X)	0.	0.				

```
      PROGRAM    LOONG                          CDC 6600 FTN V3.0-P336 OPT=1  06/04/74  14.52.11.     PAGE    1
           PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
           REAL MY,MZ,MX
           READ 1001,FL,AL,FSB,ASB
           WRITE(6,99)
      C
      C    CALCULACTIONS OF MOMENT ARMS
      C
           CG=64.6
           XLA=AL-CG
           XLF=CG-FL
           XLBA=ASB-CG
           XLBF=CG-FSB
           BETA=21.5/57.296
      C    LOAD FACTORS TIMES WT OR MOMINT OF INERTIA
      C
           SB=1.00
           E1=0.
           CX=1.60
           H=1.20
           R=12.3
           XY=1162313./386.
           XZ=1155313./386.
           WT=1439.
      C
      C
           ALOADX=0.0
           ALOADY=0.0
           ALOADZ=0.0
           MX=0.
           XMM=0.0
           XMN=0.0
        18 READ 1002,A,B,C,D,E,L
           PX=A*WT+ALOADX
           PY=B*WT+ALOADY
           PZ=C*WT+ALOADZ
           MY=D*XY+XMM
           MZ=E*XZ+XMN
           IF(L.NE.0)GO TO 691
      C
      C
      C    TRIAL LDG REACTIONS
      C
           ARM=R+H-E1
           VBE=((PY*(R+H)-MX)*XLBA+SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
           VBB=((PY*(R+H)-MX)*XLBF-SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
           VBF=ABS(VBE)
           VBA=ABS(VBB)
           RFPZ=(PX*(R+CX)-PZ*XLA-MY+VBF*(XLA+XLBF)-VBA*(XLBA-XLA))/(XLA+XLF)
           RAPZ=(MY-PX*(R+CX)-PZ*XLF+VBA*(XLF+XLBA)-VBF*(XLBF-XLF))/(XLA+XLF)
      C    TESTING FOR CASE TO BE USED
      C
           IF(RFPZ.GE.0.0.AND.RAPZ.GE.0.0) GO TO 21
           IF(RFPZ.GE.0.0.AND.RAPZ.LT.0.0) GO TO 27
           IF(RFPZ.LT.0.0.AND.RAPZ.GE.0.0) GO TO 38
           IF(RFPZ.LT.0.0.AND.RAPZ.LT.0.0) GO TO 49
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS

NX	NY	NZ	THETA	PSI
0.00	0.00	0.00	0.00	0.00

LOADING POINTS

LUG			FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	6481.	3443.	3448.	0.	0.
(Y)	0.	0.				
(X)	0.	-11512.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS

NX	NY	NZ	THETA	PSI
0.00	-1.50	0.00	0.00	0.00

LOADING POINTS

LUG			FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	6265.	2612.	0.	7715.	1820.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS

NX	NY	NZ	THETA	PSI
0.00	0.00	4.00	0.00	0.00

LOADING POINTS

LUG			FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	1427.	3561.	3600.	0.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOAD ANALYSIS MIL-A-8591 E

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LOADING CONDITION INERTIA

LOAD FACTORS

NX	NY	NZ	THETA	PSI
0.00	0.00	0.00	12.00	0.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	1445.	777.	777.	0.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS

NX	NY	NZ	THETA	PSI
0.00	0.00	0.00	0.00	-6.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	2281.	2281.	0.	2452.	2452.	0.
(Y)	0.	0.				
(X)	0.	0.				

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```
PROGRAM   LOONG                                COC 6600 FTN V3.0-P336 OPT=1  06/04/74  15.11.28.     PAGE    1

          PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
          REAL MY,MZ,MX
          READ 1001,FL,AL,FSB,ASB
          WRITE(6,99)
      C
      C   CALCULATIONS OF MOMENT ARMS
      C
          CG=64.6
          XLA=AL-CG
          XLF=CG-FL
          XLBA=ASB-CG
          XLBF=CG-FSB
          BETA=21.5/57.296
      C   LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
      C
          S3=1.00
          E1=0.
          CX=1.60
          H=1.20
          R=12.3
          XY=1162313./386.
          XZ-1156313./386.
          WT=1439.
      C
      C
          ALOADX=0.0
          ALOADY=0.0
          ALOADZ=0.0
          MX=1000.
          XMM=0.0
          XMN=0.0
```

LUG ANALYSIS MIL-A-8591 E

LOADING CONDITION ROLL ONLY

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	0.00	0.00	0.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	215.	90.	0.	265.	53.	0.
(Y)	-77.	3.				
(X)	0.	0.				

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PROGRAM LOONG   CDC 6400 FTN V3.0-P336 OPT=1 06/04/74 15.19.55. PAGE 1

```
      PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
      REAL MY,MZ,MX
      READ 1001,FL,AL,FSR,ASR
      WRITE(6,99)
C
C     CALCULACTIONS OF MOMENT ARMS
C
      CG=62.7
      XLA=AL-CG
      XLF=CG-FL
      XLBA=ASR-CG
      XLBF=CG-FSR
      BETA=21.5/57.296
C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
C
      SB=1.00
      E1=0.
      CX=1.50
      H=1.20
      R=12.3
      XY=1085596./386.
      XZ=1079596./386.
      WT=1170.
C
C
      ALOADX=0.0
      ALOADY=0.0
      ALOADZ=0.0
      MX=0.
      XMM=0.0
      XMN=0.0
   10 READ 1002,A,B,C,D,E,L
      PX=A*WT+ALOADX
      PY=B*WT+ALOADY
      PZ=C*WT+ALOADZ
      MY=D*XY+XMM
      MZ=E*XZ+XMN
      IF(L.NE.0)GO TO 691
C
C
C     TRIAL LUG REACTIONS
C
      ARM=R+H-E1
      VBF=((PY*(R+H)-MX)*XLBA+SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
      VBA=((PY*(R+H)-MX)*XLBF-SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
      VBF=ABS(VBF)
      VBA=ABS(VBA)
      REPZ=(PX*(R+CX)-PZ*XLA-MY+VBF*(XLA+XLBF)-VBA*(XLBA-XLA))/(XLA+XLF)
      RAPZ=(MY-PX*(R+CX)-PZ*XLF+VBA*(XLF+XLBA)-VBF*(XLBF-XLF))/(XLA+XLF)
C     TESTING FOR CASE TO BE USED
C
      IF(REPZ.GE.0.0.AND.RAPZ.GE.0.0) GO TO 21
      IF(REPZ.GE.0.0.AND.RAPZ.LT.0.0) GO TO 27
      IF(REPZ.LT.0.0.AND.RAPZ.GE.0.0) GO TO 38
      IF(REPZ.LT.0.0.AND.RAPZ.LT.0.0) GO TO 49
```

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LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	-9.00	0.00	0.00	0.00	0.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FOWARD SWAY BRACE LEFT	FOWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	0.	5244.	2818.	2819.	0.	0.
(Y)	0.	0.				
(X)	0.	-9432.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	-1.50	0.00	0.00	0.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FOWARD SWAY BRACE LEFT	FOWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	5560.	2567.	0.	6790.	1954.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	4.00	0.00	0.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FOWARD SWAY BRACE LEFT	FOWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	0.	1529.	3355.	3355.	0.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOAD ANALYSIS MIL-A-8591 E

23

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	0.00	12.00	0.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	0.	1350.	725.	729.	0.	0.
(Y)	0.	0.				
(X)	0.	0.				

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	0.00	0.00	-6.00

LOADING POINTS

	LUG		FORWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	2130.	2130.	0.	2289.	2289.	0.
(Y)	0.	0.				
(X)	0.	0.				

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```
PROGRAM     LOONG                                        CDC 6600 FTN V3.0-P336 OPT=1  06/06/76  15.16.33.     PAGE    1

                   PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
                   REAL NY,NZ,NX
                   READ 1001,FL,AL,FSB,ASB
                   WRITE(6,99)
             C
             C     CALCULACTIONS OF MOMENT ARMS
             C
                   CG=52.7
                   XLA=AL-CG
                   XLF=CG-FL
                   XLBA=ASB-CG
                   XLBF=CG-FSB
                   BETA=21.5/57.296
             C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
             C
                   SB=1.00
                   S1=0.
                   DX=1.60
                   H=1.20
                   P=12.3
                   XY=108559E./386.
                   XZ=1073596./386.
                   WT=1179.
             C
             C
                   ALOADX=0.0
                   ALOADY=0.0
                   ALOADZ=0.0
                   NX=1630.
                   XMM=0.0
                   XMN=0.0
                10 READ 1002,A,B,C,D,E,L
                   DX=A*WT+ALOADX
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION ROLL ONLY

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	0.00	0.00	0.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FOWARD SWAY BRACE LEFT	FOWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	233.	109.	0.	284.	92.	0.
(Y)	-82.	0.				
(X)	0.	0.				

25

```
PROGRAM     LODNS                              CDC 6600 FTN V3.0-P336 OPT=1  06/04/74  15.21.51.      PAGE    1
            PROGRAM LODNS (INPUT,OUTPUT,TAPE6=OUTPUT)
            REAL MY,MZ,MX
            READ 1001,FL,AL,FSB,ASB
            WRITE(6,99)
      C
      C     CALCULATIONS OF MOMENT ARMS
      C
            CG=59.7
            XLA=AL-CG
            XLF=CG-FL
            XLBA=ASB-CG
            XLBF=CG-FSB
            BETA=21.5/57.296
      C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
      C
            SB=1.00
            E1=0.
            CX=1.60
            H=1.20
            R=12.3
            XY=995240./386.
            XZ=990240./386.
            WT=919.
      C
      C
            ALOADX=0.0
            ALOADY=0.0
            ALOADZ=0.0
            MX=0.
            XMM=0.0
            XMN=0.0
         10 READ 1002,A,B,C,D,E,L
            PX=A*WT+ALOADX
            PY=B*WT+ALOADY
            PZ=C*WT+ALOADZ
            MY=D*XY+XMM
            MZ=E*XZ+XMN
            IF(L.NE.0)GO TO 691
      C
      C
      C     TRIAL LUG REACTIONS
      C
            ARM=R+H-E1
            VBF=(TPY*(R+H)-MX)*XLBA+SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
            VBA=((PY*(R+H)-MX)*XLBF-SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
            VBF=ABS(VBF)
            VBA=ABS(VBA)
            RFPZ=(PX*(R+CX)-PZ*XLA-MY+VBF*(XLA+XLBF)-VBA*(XLBA-XLA))/(XLA+XLF)
            RAPZ=(MY-PX*(R+CX)-PZ*XLF+VBA*(XLF+XLBA)-VBF*(XLBF-XLF))/(XLA+XLF)
      C     TESTING FOR CASE TO BE USED
      C
            IF(RFPZ.GE.0.0.AND.RAPZ.GE.0.0) GO TO 21
            IF(RFPZ.GE.0.0.AND.RAPZ.LT.0.0) GO TO 27
            IF(RFPZ.LT.0.0.AND.RAPZ.GE.0.0) GO TO 38
            IF(RFPZ.LT.0.0.AND.RAPZ.LT.0.0) GO TO 49
```

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LOAD ANALYSIS MIL-A-8591 E

	NX	NY	NZ	THETA	PSI
LOAD FACTORS	-0.50	0.00	0.00	0.00	0.00

LOADING CONDITION INERTIA

LOADING POINTS

LUG	FORWARD	AFT
(Z)	0.	4883.
(Y)	0.	0.
(X)	0.	-7344.

FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
2194.	2194.	0.	0.

LOAD ANALYSIS MIL-A-8591 E

	NX	NY	NZ	THETA	PSI
LOAD FACTORS	0.00	-1.50	0.00	0.00	0.00

LOADING CONDITION INERTIA

LOADING POINTS

LUG	FORWARD	AFT
(Z)	4853.	2523.
(Y)	0.	0.
(X)	0.	0.

FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
0.	5842.	2085.	0.

LOAD ANALYSIS MIL-A-8591 E

	NX	NY	NZ	THETA	PSI
LOAD FACTORS	0.00	0.00	4.00	0.00	0.00

LOADING CONDITION INERTIA

LOADING POINTS

LUG	FORWARD	AFT
(Z)	0.	1570.
(Y)	0.	0.
(X)	0.	0.

FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
2849.	2849.	0.	0.

LOAD ANALYSIS MIL-A-8591 E

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LOADING CONDITION INERTIA

LOAD FACTORS

NX	NY	NZ	THETA	PSI
0.00	0.00	0.00	12.00	0.00

LOADING POINTS

	LUG	
	FORWARD	AFT
(Z)	0.	1239.
(Y)	0.	0.
(X)	0.	0.

FORWARD SWAY BRACE		AFT SWAY BRACE	
LEFT	RIGHT	LEFT	RIGHT
666.	666.	0.	0.

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION INERTIA

LOAD FACTORS

NX	NY	NZ	THETA	PSI
0.00	0.00	0.00	0.00	-6.00

LOADING POINTS

	LUG	
	FORWARD	AFT
(Z)	1954.	1954.
(Y)	0.	0.
(X)	0.	0.

FORWARD SWAY BRACE		AFT SWAY BRACE	
LEFT	RIGHT	LEFT	RIGHT
0.	2100.	2100.	0.

28

```
PROGRAM     LOONG                              CDC 6600 FTN V3.0-P336 OPT=1  06/04/74  15.24.36.      PAGE    1

            PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
            REAL MY,MZ,MX
            READ 1001,FL,AL,FSB,ASB
            WRITE(6,99)
      C
      C     CALCULACTIONS OF MOMENT ARMS
      C
            CG=99.7
            XLA=AL-CG
            XLF=CG-FL
            XLBA=ASB-CG
            XLBF=CG-FSB
            BETA=21.5/57.295
      C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
      C
            SB=1.00
            E1=0.
            CX=1.60
            H=1.20
            P=12.3
            XY=996240./386.
            XZ=998240./386.
            WT=918.
      C
      C
            ALOADX=0.0
            ALOADY=0.0
            ALOADZ=0.0
            MX=1000.
            XMM=0.0
            XMN=0.0
         10 READ 1002,A,B,C,D,E,L
            PX=A*WT+ALOADX
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION ROLL ONLY

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	0.00	0.00	0.00	0.00	0.00

LOADING POINTS

	LUG FORWARD	LUG AFT	FORWARD SWAY BRACE LEFT	FORWARD SWAY BRACE RIGHT	AFT SWAY BRACE LEFT	AFT SWAY BRACE RIGHT
(Z)	261.	136.	0.	314.	112.	0.
(Y)	-89.	15.				
(X)	0.	0.				

29

Towing Frames

```
PROGRAM      LOONG                          CDC 6600 FTN V3.0-133B OPT=1  06/11/74  09.39.47.      PAGE    1

                   PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
                   REAL MY,MZ,MX
                   READ 1001,FL,AL,FSB,ASB
                   WRITE(6,99)
             C
             C     CALCULACTIONS OF MOMENT ARMS
             C
                   CG=62.7
                   XLA=AL-CG
                   XLF=CG-FL
                   XLBA=ASB-CG
                   XLBF=CG-FSB
                   BETA=21.5/57.295
             C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
             C
                   SB=1.00
                   E1=0.
                   CX=1.68
                   H=1.20
                   R=12.3
                   XY=1085596./386.
                   XZ=1079596./386.
                   WT=1179.
             C
             C
                   ALOADX=6006.
                   ALOADY=610.
                   ALOADZ=716.
                   MX=-2563.
                   XMM=-76255.
                   XMN=-48556.
```

LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>TON   LOAD FACTORS

NX	NY	NZ	THETA	PSI
1.50	-.70	-2.00	-4.00	-2.00

LOADING POINTS

	LUG		FOWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	15784.	222.	0.	7485.	7416.	0.
(Y)	209.	-20.				
(X)	7774.	0.				

30

NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ
NSTTSSZ

```
PROGRAM    ORBITNG                                 CDC 6600 FTN V3.0-P336 OPT=1  05/10/74  10.40.37.     PAGE    1

           PROGRAM ORBITNG(INPUT,OUTPUT)
   C       TOWLINE STEADY STATE CONFIGURATION----TOWPLANE IN LEFT TURN
   C V = TOWPLANE TRUE AIRSPEED , KNOTS                                                3
   C RPL = TOWPLANE TURN RADIUS, BALL CENTER, LEFT TURN, FT
   C ZPL = TOWPLANE DENSITY ALTITUDE FT                                                5
   C AMG = TARGET WEIGHT , LB.                                                         6
   C ABASE = TARGET BASE AREA , SQ FT                                                  7
   C CDDROG = TARGET DRAG COEFFICIENT                                                  8
   C AMUG = TOWLINE WEIGHT, LB/FT                                                      9
   C D = TOWLINE DIAMETER, FT                                                          10
   C AL = TOWLINE LENGHT , FT                                                          11
   C PICF = TOWLINE SKIN FRICTION COEFFICIENT                                          12
   C CD = TOWLINE DRAG COEFFICIENT                                                     13
   C       XCG = DISTANCE FROM TOWPOINT TO TARGET CENTER OF GRAVITY, FT
   C       XCP = DISTANCE FROM TOWPOINT TO TARGET CENTER OF PRESSURE ,FT               15
   C       ZCL = DISTANCE FROM TOWPOINT TO TARGET CENTERLINE, FT
   C       THETA = TOWLINE TRAIL ANGLE AT TARGET, XZ PLANE, RADIANS
   C       PHI = TARGET BANK ANGLE, RADIANS
   C       CONSTANT                                                                    18
           G = 32.17 $PI = 3.1416                                                      19
           XCG = 0.750 $XCP = 4.500 $ZCL = 1.500
      1199 ITER = 1                                                                    21
           READ 1001, V, RPL, ZPL, RZD, ZZD                                            22
           IF (V - 9999.)1200, 340, 340                                                23
      1200 PRINT 1101,V, RPL, ZPL, RZD, ZZD                                            24
           READ 1002, AMG, ABASE, CDDROG                                               25
           PRINT 1102, AMG, ABASE, CDDROG                                              26
           READ 100    AMUG, D, AL, DDS, PICF, CD                                      28
           PRINT 1103, AMUG, D, AL, DDS, PICF, CD                                      29
           IF (CD - 0.1) 1199, 1199, 1400                                              30
      1400 K = 1                                                                       31
         5 ITER = ITER + 1                                                             32
           IF (ITER - 30) 1501, 1501, 560                                              33
      1501 ZZ = ZZD $RZ = RZD $I = 1  $DS = 2.0 $OMEGA = V*1.69/RPL $N = 1             34
           RHOZ = 0.002378*(1. - 0.006875*ZZ/1000.)**4.256                             35
           OMEGSQ = OMEGA*OMEGA $J = 0.0 $THZ = 0.0                                    36
           CDSQ = 0.5*RHOZ*RZ*RZ*OMEGSQ*ABASE*CDDROG
           A = RZ*OMEGSQ/G
           PHI = ATAN(A)
           ANZ = 1./COS(PHI)
           A = ZCL/XCP
           B = XCG/XCP
           C = 1.-B
           B = AMG*C*ANZ/CDSQ
           C = A+B
           THETA = ATAN(C)
           TDROG = CDSQ/COS(THETA)
     12030FORMAT (1H , 3X, 4HPHI=, E12.4, 5X, 6HTHETA=, E12.4, 5X,
          16HTDROG=8 E12.4)
           TRPZ = -TDROG*SIN(THETA)*SIN(PHI)
           TZPZ = TDROG*SIN(THETA)*COS(PHI)
           TRTHPZ = TDROG*COS(THETA)
       660 TZ = SQRT(TRPZ*TRPZ+TRTHPZ*TRTHPZ+TZPZ*TZPZ)                                65
           RPZ= TRPZ/TZ $THPZ =TRTHPZ/(TZ*RZ) $ZPZ = TZPZ/TZ                           66
           RTHPZ =THPZ*RZ                                                              67
```

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PROGRAM ORBITNG . CDC 6600 FTN V3.0-P336 OPT=1 05/10/74 10.40.37. PAGE 2

```
      PRINT 1
      PRINT 2, S, RZ, ZZ, THZ, TZ, RPZ, ZPZ, RTHPZ
    8 S = S+DS
      Z = ZZ $T = TZ $R = RZ $RP = RPZ $THP = THPZ $ZP = ZPZ $KK = 1
   10 ZA = 0.5*(Z+ZZ) $TA = 0.5*(T+TZ) $RA = 0.5*(R+RZ)
      THPA = 0.5*(THP+THPZ) $ZPA = 0.5*(ZP+ZPZ) $RPA=0.5*(RP+RPZ)
      RHO = 0.002376*(1.-0.00687*ZA/1000.)**4.256
      THPASQ = THPA*THPA $RASQ = RA*RA
      QD = 0.5*RHO*D*RASQ*OMEGSQ*CD
      STRTH = SQRT(1.-RASQ*THPASQ)
      TRP = (TA*RA*THPASQ-AMUG/G*RA*OMEGSQ-QD*RA*RPA*THPA*STRTH)*DS+TRPZ
     0TRTHP=(-TA*RPA*THPA+QD*STRTH**3.+0.5*RHO*D*PICF*RASQ*OMEGSQ)*DS+TR
     1THPZ
      TZP = (AMUG- QD*RA*THPA*ZPA*STRTH)*DS+TZPZ
      T1 = SQRT(TRP*TRP+TRTHP*TRTHP+TZP*TZP)
      RP1 = TRP/T1 $R1 = RZ+(RP1+RPZ)*0.5*DS
      THP1 = TRTHP/(T1*R1) $ZP1 = TZP/T1
      Z1 = ZZ+0.5*(ZP1+ZPZ)*DS $RTHP1 = THP1*R1
      TH1 = THZ+(THPZ+THP1)*0.5*DS
      IF (ABS((Z1-Z)/Z) .GT. 0.001)100, 101
  101 IF (ABS((R1-R)/R) .GT. 0.001) 100, 102
  102 IF (ABS((T1-T)/T).GT. 0.001)  100, 32
 32   IF(I.GT.18)I=18
      IF(I.LT.1)I=1
      GO TO (33, 34, 35, 35, 35, 35, 36, 36, 36, 36, 37, 37, 37, 37, 38,
     138, 39, 40),I
   33 DS = 5.
      GO TO 49
   34 DS = 13.
      GO TO 49
   35 DS = 20.
      GO TO 49
   36 DS = 30.
      GO TO 49
   37 DS = 40.
      GO TO 49
   38 DS = 60.
      GO TO 49
   39 DS = 100.
      GO TO 49
   30 PRINT 3
      GO TO 32
   40 IF (S-AL+DDS) 50, 48, 100
   48 DS = DDS
   49 I = I+1
   50 ZZ = Z1 $RZ = R1 $TZ = T1 $RPZ = RP1 $THPZ = THP1 $ZPZ = ZP1
      THZ = TH1  $TRPZ=TRP $TRTHPZ=TRTHP $TZPZ=TZP
      GO TO (120, 120, 110),K
  110 PRINT 2, S, R1, . , TH1, T1, RP1, ZP1, RTHP1
  120 GO TO 8
  100 IF ( KK.GT. 20) 30, 150
  150 Z = Z1 $R = R1 $T = T1 $RP = RP1 $THP = THP1 $ZP = ZP1
      RTHP = RTHP1 $KK= KK+ 1
      GO TO 10
    1 FORMAT (1H , 5X, 1HS, 11X, 1HR, 11X, 1HZ, 11X, 2HTH, 10X, 1HT, 10X
```


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```
     1, 2HRP, 18X, 2HZP, 9X, 4HRTHP)
   2 FORMAT (8E12.4)
   3 FORMAT (13H NOT CONVERGE)
1000 FORMAT (1H1, 14HRINOT CONVERGE)
1001 FORMAT (5E12.4)
1101OFORMAT (1H , 8HV(KNOT)=,E12.4,2X,4HRPL=,E12.4,2X,4HZPL=,E12.4,2X,
    1 4HRZO=,E12.4,2X,4HZZO=,E12.4)
1002 FORMAT (5X, 3E12.4)
1102 FORMAT (1H ,4HANG=,E12.4,2X,5HABASE=,E12.4,2X,7HCDOROG=,E12.4)
1003 FORMAT (5X, 4E12.4, 1X, 2E9.2)
1103 FORMAT (1H ,5HAMUG=,E12.4,2X,2HD=,E12.4,2X,3HAL=,E12.4,2X,4HDDS=,
    1E12.4,2X,5HPICF=,E12.4,2X,3HCD=,E12.4)
1301CFORMAT (1H1, 5X, 3HRPL, 9X, 5HRDROG, 7X, 3HZPL, 9X, 5HZDROG, 7X,
    13HSEP, 9X, 1HT, 11X, 4HRPPL, 8X, 4HZPPL, 6X, 4HTHPL)
1311 FORMAT (9E12.4)
 190 PRINT 2 , S, R1, Z1, TH1, T1, RP1, ZP1, RTHP1
     GO TO ( 3, 203, 1193),K
 200 IF (ABS((Z1-ZPL)/ZPL)-0.010)202, 210, 210
 202 GO TO (203, 240),K
 203 IF (ABS(Z1-ZPL)-2000.) 204, 204, 210
 204 IF (ABS((R1-RPL)/RPL)-0.003) 206, 220, 220
 206 GO TO (240, 200),K
 210 K = 1
     ZZO = ZZO +0.6*(ZPL-Z1)
     GO TO 5
 220 GO TO (510, 515),K
 510 DRZO = 0.16*(RPL - R1)
     GO TO 560
 515 IF (ABS((R1-RSTORE)/RPL)- 0.002) 516, 516, 520
 516 DRZO = 0.2*(RPL - R1)
 520 DRZO =(RPL-R1)*DRZO*0.6/(R1-RSTORE)
     IF (ABS(DRZO)- 150.) 528, 525, 525
 525 DRZO =  150.*DRZO/ABS(DRZO)
     GO TO 560
 528 IF (ABS(DRZO)- 5. ) 529, 529, 560
 529 DRZO =  5. *DRZO/ABS(DRZO)
 560 RZO = RZO + DRZO
     K = 2
     RSTORE = R1
     GO TO 5
 540 PRINT 1000
     GO TO 1193
 240 K = 3
     PRINT 1301
     PRINT 1101,V, RPL, ZPL, RZO, ZZO
     PRINT 1102, ANG, ABASE, CDDROG
     PRINT 1103, AMUG, D, AL, DDS, PICF, CD
     PRINT 1203, PHI, THETA, TORQ
     GO TO 5
 340 STOP
     END
```


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```
PROGRAM     ORBITNG                              CDC 6600 FTN V3.0-P336 OPT=1  05/16/74  10.40.37.       PAGE     6

 CARD NO.  SEVERITY           DIAGNOSTIC
       40       -1     22 CO 49 TOTAL RECORD LENGTH IS GREATER THAN 137 CHARACTERS.  IT MAY EXCEED THE I/O DEVICE CAPACITY.
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        PROGRAM     ORBITNG                                   CDC 6600 FTN V3.0-P336 OPT=1  05/10/74  10.48.37.      PAGE     5

        SYMBOLIC REFERENCE MAP

    ENTRY POINTS      DEF LINE     REFERENCES
     4058  ORBITNG        1

    VARIABLES      SN  TYPE           RELOCATION
     5307  A            REAL                          REFS        39      45   DEFINED      38      41
     5263  ABASE        REAL                          REFS        27      37      156  DEFINED      26
     5267  AL           REAL                          REFS        29      90      157  DEFINED      28
     5262  AMU          REAL                          REFS        27      44      156  DEFINED      26
     5265  AMUG         REAL                          REFS        29      66       69      157  DEFINED      28
     5311  ANZ          REAL                          REFS        44  DEFINED      40
     5312  B            REAL                          REFS        43      45   DEFINED      42      44
     5313  C            REAL                          REFS        44      46   DEFINED      43      45
     5272  CD           REAL                          REFS        29      38       64      157  DEFINED      28
     5264  CDDROG       REAL                          REFS        27      37      156  DEFINED      26
     5306  COSQ         REAL                          REFS        46      47   DEFINED      37
     5266  D            REAL                          REFS        29      64       67      157  DEFINED      28
     5270  DDS          REAL                          REFS        29      98       99      157  DEFINED      28
     5364  DRZD         REAL                          REFS       141     142    2*143      145    2*146     147
                                                   DEFINED       137     140      141      143      146
     5277  DS           REAL                          REFS        58      66       67       69       71      73      74
                                                   DEFINED        34      82       84       86       88      90      92
                                                                  96      99
     5247  G            REAL                          REFS        38      66   DEFINED      28
     5276  I            INTEGER                       REFS        78      79       88      100  DEFINED      34      78
                                                                  79     100
     5254  ITER         INTEGER                       REFS        32      33   DEFINED      22      32
     5273  K            INTEGER                       REFS       103     127      129      132      136
                                                   DEFINED        31     133      148      153
     5334  KK           INTEGER                       REFS       106     108  DEFINED      59     138
     5301  M          * INTEGER                    DEFINED        34
     5308  OMEGA        REAL                          REFS      2*36  DEFINED      34
     5303  OMEGSQ       REAL                          REFS        37      38       64       66      67
                                                   DEFINED        36
     5310  PHI          REAL                          REFS        40      58       51      158  DEFINED      39
     5250  PI         * REAL                       DEFINED        20
     5271  PICF         REAL                          REFS        29      67      157  DEFINED      28
     5340  QD           REAL                          REFS        66      67       69  DEFINED      64
     5330  R            REAL                          REFS        60    2*76  DEFINED      59     107
     5337  RA           REAL                          REFS      2*63    3*64       69  DEFINED      58
     5345  RASQ         REAL                          REFS        64      65       67  DEFINED      63
     5343  RHO          REAL                          REFS        64      67  DEFINED      62
     5302  RHOZ         REAL                          REFS        37  DEFINED      35
     5331  RP           REAL                          REFS        61  DEFINED      59      107
     5342  RPA          REAL                          REFS        66      67  DEFINED      61
     5256  RPL          REAL                          REFS        25      34    2*131      137     139     140     141
                                                                 155  DEFINED      23
     5322  RP7          REAL                          REFS        57      59       61       71  DEFINED      54     181
     5354  RP1          REAL                          REFS        71     101      104      107     126
                                                   DEFINED        71
     5365  RSTORE       REAL                          REFS       139     141  DEFINED     149
     5363  RTHP       * REAL                       DEFINED       106
     5325  RTHPZ        REAL                          REFS        57  DEFINED      55
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        PROGRAM    ORBITNG                              CDC 6600 FTN V3.0-P336 OPT=1  05/10/74  10.40.37.     PAGE    6

   VARIABLES     SN  TYPE          RELOCATION
   5361  RTMP1       REAL                        REFS       104      100      126   DEFINED      73
   5275  RZ          REAL                        REFS      2*37       38       54        55      57       59       60
                                                   71   DEFINED       34      101
   5260  RZ0         REAL                        REFS        25       34      147       155  DEFINED      23      147
   5355  R1          REAL                        REFS        72       73       76       101     104      107      126
                                                  131       137      139      140     2*141     149
                                              DEFINED        71
   5304  S           REAL                        REFS        57       58       98       104     126
                                              DEFINED        36       58
   5347  STRTM       REAL                        REFS        66       67       69   DEFINED      55
   5327  T           REAL                        REFS        60     2*77  DEFINED        59     107
   5330  TA          REAL                        REFS        66       67  DEFINED        60
   5315  TBROG       REAL                        REFS        50       51       52       150  DEFINED      47
   5314  THETA       REAL                        REFS        47       50       51        52     130
                                              DEFINED        46
   5332  THP         REAL                        REFS        61  DEFINED       59       107
   5340  THPA        REAL                        REFS      2*63       66       67        69  DEFINED      61
   5344  THPASQ      REAL                        REFS        65       66  DEFINED        63
   5323  THPZ        REAL                        REFS        55       59       61        74  DEFINED      54      101
   5350  THP1        REAL                        REFS        73       74      101       107  DEFINED      72
   5305  THZ         REAL                        REFS        57       74  DEFINED        36     102
   5302  TH1         REAL                        REFS       102      104      126   DEFINED      74
   5350  TRP         REAL                        REFS      2*70       71      102   DEFINED      56
   5313  TRPZ        REAL                        REFS      2*53       54       66   DEFINED      58      102
   5351  TRTMP       REAL                        REFS      2*70       72      102   DEFINED      57
   5320  TRTMPZ      REAL                        REFS      2*53       54       67   DEFINED      52      102
   5321  TZ          REAL                        REFS      3*54       57       59        60  DEFINED      53      101
   5352  TZP         REAL                        REFS      2*70       72      102   DEFINED      59
   5317  TZPZ        REAL                        REFS      2*53       54       69   DEFINED      51      102
   5353  T1          REAL                        REFS        71     2*72       77       101     104      107      126
                                              DEFINED        70
   5255  V           REAL                        REFS        24       25       34       155  DEFINED      23
   5251  XCG         REAL                        REFS        42  DEFINED       21
   5252  XCP         REAL                        REFS        41       42  DEFINED        21
   5326  Z           REAL                        REFS        60     2*75  DEFINED        59     107
   5335  ZA          REAL                        REFS        62  DEFINED       60
   5253  ZCL         REAL                        REFS        41  DEFINED       21
   5333  ZP          REAL                        REFS        61  DEFINED       59       107
   5341  ZPA         REAL                        REFS        69  DEFINED       61
   5257  ZPL         REAL                        REFS        25    2*128      130       134     135
                                              DEFINED        23
   5324  ZPZ         REAL                        REFS        57       59       61        73  DEFINED      54      101
   5357  ZP1         REAL                        REFS        73      101      104       137     126
                                              DEFINED        72
   5274  ZZ          REAL                        REFS        35       57       59        60      73
                                              DEFINED        34      101
   5261  ZZ0         REAL                        REFS        25       34      134       155  DEFINED      23      134
   5360  Z1          REAL                        REFS        75      101      104       107     126      128      130
                                                  134   DEFINED       73

   FILE NAMES        MODE
      0  INPUT        FMT              READS      23        26       28
   2022  OUTPUT       FMT             WRITES      25        27       29       56        57      36      144      126
                                         151     154       155      156      157       158
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PROGRAM     ORBITING                                    CDC 6600 FTN V3.0-P336 OPT=1  05/10/74  10.40.37.     PAGE     7

EXTERNALS          TYPE   ARGS        REFERENCES
      ATAN         REAL     1 LIBRARY     39        46
      COS          REAL     1 LIBRARY     40        47        51        52
      SIN          REAL     1 LIBRARY     2*50      51
      SQRT         REAL     1 LIBRARY     53        65        78

INLINE FUNCTIONS   TYPE   ARGS      DEF LINE   REFERENCES
      ABS          REAL     1  INTRIN               75        76        77       120       130       131       139       142
                                                   143       145       145

STATEMENT LABELS               DEF LINE    REFERENCES
  5115  1         FMT             110         56
  5124  2         FMT             112         57        104       120
  5126  3         FMT             113         96
  4202  5                          32        135        158       159
  4330  8                          58        105
  4344  10                         60        109
  4540  30                         96        106
  4472  32                         78         77         97
  4530  33                         82         80
  4532  34                         84         80
  4534  35                         86        4*80
  4536  36                         88        4*80
  4540  37                         90        4*80
  4542  38                         92        2*80
  4544  39                         94         80
  4552  40                         96         80
     0  48         INACTIVE        99         98
  4560  49                        100         83         85        87        89        91        93        95
  4562  50                        101         98
  4633  100                       106         75         76        77
     0  101        INACTIVE        76         75
     0  102        INACTIVE        77         76
  4607  110                       104        103
  4632  120                       105       2*103
     0  150        INACTIVE       107        106
  4651  190                       126         98
  4703  200                       128        127        132
     0  202        INACTIVE       129        128
  4710  203                       130        127
  4723  204                       131        123       2*130
     0  206        INACTIVE       132        131
  4736  213                       133       2*128       130
  4743  220                       136       2*131
  5017  240                       153        129        132
  5102  340                       160       2*24
  4751  510                       137        136
  4755  515                       139        136
     0  516        INACTIVE       140       2*139
  4765  520                       141        139
     0  525        INACTIVE       143        142
  5008  528                       145       2*142
     0  529        INACTIVE       146       2*145
  5013  540                       151         33
  5066  560                       147        139        144       145
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        PROGRAM    ORBITNG                                          CDC 6600 FTN V3.0-P336 OPT=1  05/10/74  10.40.37.     PAGE    8

  STATEMENT LABELS                          DEF LINE   REFERENCES
        0   660              INACTIVE           53
     5131  1000     FMT                        114        151
     5135  1001     FMT                        115         23
     5150  1002     FMT                        118         26
     5160  1003     FMT                        120         28
     5147  1101     FMT                        116         25       155
     5152  1102     FMT                        119         27       156
     5163  1103     FMT                        121         29       157
     4060  1199                                 22       2*30       127        152
        0  1200              INACTIVE           25         24
     5106  1203     FMT                         48        158
     5175  1301     FMT                        123        154
     5206  1311     FMT      NO REFS           125
        0  1400              INACTIVE           31         38
        0  1501              INACTIVE           34       2*33

  STATISTICS
    PROGRAM LENGTH          1324B     724
     BUFFER LENGTH          4044B    2084
```

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```
CORE MAP  10.48.56.  NORMAL              CONTROL                                                    000100    014126    000000    000000
          ---TIME---LOAD MODE --L1--L2----TYPE---------------USER-------CALL-------------FWA LOAD--LWA LOAD--BLNK COMM--LENGTH--
          FWA LOADER  053171  FWA TABLES  051145
          -PROGRAM----ADDRESS-                   --LABEL(S)---COMMON----ADDRESS-
          ORBITNG     000100
          GETBA       005470
          SYSTEMS     005507
          AGGOERS     005521
          INPUTCS     005534
          KODERS      006670
          KRAKERS     010304
          OUTPTCS     012031
          ALNLOGE     012125
          ATANE       012144
          EXPE        012245
          SINCOSE     012311
          SQRTE       012366
          XTOYE       012410
          SIOS        012417
          --ENTRY-----ADDRESS-                                    REFERENCES
          ORBITNG     004150
          INPUT#      000100
          OUTPUT#     002122
          GETBA       005471            SIOS        012702

          FLSCM.      005513
          FLLCM.      005514
          ABNTRY.     005515            ORBITNG     004150

          END.        005532            ORBITNG     005204

          EXITS       005560
          STOP.       005564            ORBITNG     005203

          ABNORM.     005573            AGGOERS     006525
                                        INPUTCS     006615
                                        KODERS      007777
                                        KRAKERS     011334    011447
                                        OUTPTCS     012124

          SYSTEME     005611
          SYSTEMS     005635
          SYSTEM.     005641
          SYSTEMX     005676            AGGOERS     005524
                                        INPUTCS     006616
                                        KODERS      007743    007761    007774    007776
                                        KRAKERS     011144    011161    011260    011305    011333    011365    011413
                                                    011431    011444    011446
                                        OUTPTCS     012123

          SYS1X       006103            KRAKERS     011074    011067    011262

          SYS2X       006077            KRAKERS     011251    011266

          LOTX        006312            KRAKERS     011254    011270

          ERRFLG.     006260            KODERS      007761    007773    007742
                                        KRAKERS     011412    011160    011364    011431    011443    011305    011260
                                                    011143

          OBUFET.     006332
          AGGOER.     006522            ORBITNG     005646    005033    005013    004777    004703    004585
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IPUTCI.	006575	ORBITNG	004241	004217	004162				
INPUTC.	006623	ORBITNG	004256	004255	004253	004251	004247	004245	004243
			004226	004225	004223	004221	004175	004174	004172
			004170	004166	004164				
KODER.	006571	OUTPTCS	012060	012072					
KRAKER.	010305	INPUTCS	006621	006626	006573				
ERRSETS	011022								
OPUTCI.	012062	ORBITNG	005171	005152	005141	005124	005121	005114	004752
			004710	004647	004406	004403	004260	004230	004202
OUTPTC.	012071	ORBITNG	005240	005177	005175	005173	005167	005166	005164
			005162	005160	005156	005154	005150	005147	005145
			005143	005137	005136	005134	005132	005130	005126
			005122	005115	004773	004772	004770	004766	004764
			004762	004760	004756	004754	004731	004730	004726
			004724	004722	004720	004716	004714	004712	004650
			004427	004426	004424	004422	004420	004416	004414
			004412	004410	004404	004275	004274	004272	004270
			004266	004264	004262	004237	004236	004234	004232
			004215	004214	004212	004210	004206	004204	
ALOG.	012125	XTOYE	012410						
ALOG10.	012147								
ATAN.	012164	ORBITNG	004346	004333					
EXP.	012246	XTOYE	012412						
SIN.	012311	ORBITNG	004361	004355	004353				
COS.	012313	ORBITNG	004366	004363	004350	004335			
SQRT.	012370	ORBITNG	004536	004477	004373				
XTOY.	012413								
XTOYS.	012413	ORBITNG	004513	004465	004320				
CIOI.	013517								
KCLI.	013545	SYSTEMS	006247						
DAT.	012421	SYSTEMS	005746	005777	006112	006116	006126	006150	006163
		INPUTCS	006567	006652	006660				
		KODERS	007022	007611					
		KRAKERS	013432	011046	011047	011130	011136	011340	
		OUTPTCS	012052	012104	012114				
SIO.CTL	012647	SYSTEMS	005231	005712	005674	005533			
INITL.	012700	SYSTEMS	005715	006227					
		INPUTCS	006577						
		OUTPTCS	012065						
SIO.	012747	SYSTEMS	005072	006073	006120	006122	006123	006070	
		INPUTCS	005654						
		OUTPTCS	012110						
SIO.END	013472	SYSTEMS	005244						
OPEN.	013565								

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AUPRU.     013631
BKSPRU.    013671
AUVIN.     013731            SYSTEMS     005243

POSFI.     013727
MVMDS.     014072
SYSERR.    014103            INPUTCG --- 005645

----UNSATISFIED EXTERNALS-----                           REFERENCES

V(KNOT)=   .4470E+03  RPL=   .6264E+04  ZPL=   .1000E+05  RZD=   .6264E+04  ZZD=   .9000E+04
ANG=  .5000E+03  ABASE=   .9675E+02  CDDRUG=   .4500E-01
AMUG=   .6507E-01  U=   .1517E-01  AL=   .1000E+04  UDS=   .1000E+03  PICF=   .1300E-01  CD=   .1640E+01
     S            R            Z            TH           T            RP           ZP           RTMP
  0.           .6264E+04    .9800E+04    0.           .2933E+04   -.6306E+00    .2227E+00    .7435E+00
   .1000E+04   .5996E+04    .9922E+04    .1548E+00    .3186E+04   -.1301E+00    .8151E-01    .9801E+00
     S            R            Z            TH           T            RP           ZP           RTMP
  0.           .6311E+04    .9800E+04    0.           .2990E+04   -.6294E+00    .2205E+00    .7452E+00
   .1000E+04   .6017E+04    .9920E+04    .1529E+00    .3169E+04   -.1302E+00    .8066E-01    .9862E+00
     S            R            Z            TH           T            RP           ZP           RTMP
  0.           .6450E+04    .9800E+04    0.           .3133E+04   -.6252E+00    .2141E+00    .7505E+00
   .1000E+04   .6165E+04    .9917E+04    .1495E+00    .3259E+04   -.1303E+00    .7609E-01    .9884E+00
     S            R            Z            TH           T            RP           ZP           RTMP
  0.           .6517E+04    .9800E+04    0.           .3157E+04   -.6236E+00    .2117E+00    .7526E+00
   .1000E+04   .6224E+04    .9915E+04    .1482E+00    .3320E+04   -.1303E+00    .7711E-01    .9885E+00
     S            R            Z            TH           T            RP           ZP           RTMP
  0.           .6540E+04    .9800E+04    0.           .3177E+04   -.6229E+00    .2107E+00    .7534E+00
   .1000E+04   .6248E+04    .9915E+04    .1477E+00    .3340E+04   -.1303E+00    .7672E-01    .9885E+00
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     RPL          RDROG        ZPL          ZDROG        SEP          T            RPPL         ZPPL         THPL
V(KNOT)=   .4470E+03  RPL=   .6204E+04  ZPL=   .1000E+05  RZB=   .6540E+04  ZZB=   .9800E+04
ANG=   .5000E+03  AWASE=   .9675E+02  CODROG=   .4500E-01
ANUG=   .6507E-01  O=   .1517E-01  AL=   .1000E+04  DJS=   .1000E+03  PICF=   .1300E-01  CD=   .1640E+01
   PHI=   .1245E+01     THETA=   .7176E+00     IDROG=   .3177E+04
```

S	R	Z	TH	T	RP	ZP	RTMP
0.	.6540E+04	.9800E+04	0.	.3177E+04	-.6229E+00	.2107E+00	.7534E+00
.2000E+01	.6539E+04	.9800E+04	.2368E-03	.3177E+04	-.6201E+00	.2098E+00	.7559E+00
.7000E+01	.6536E+04	.9801E+04	.8114E-03	.3178E+04	-.6131E+00	.2076E+00	.7622E+00
.2000E+02	.6528E+04	.9804E+04	.2343E-02	.3181E+04	-.5957E+00	.2021E+00	.7774E+00
.4000E+02	.6516E+04	.9808E+04	.4760E-02	.3185E+04	-.5701E+00	.1940E+00	.7984E+00
.6000E+02	.6505E+04	.9812E+04	.7249E-02	.3190E+04	-.5460E+00	.1865E+00	.8168E+00
.8000E+02	.6494E+04	.9816E+04	.9779E-02	.3194E+04	-.5233E+00	.1794E+00	.8330E+00
.1000E+03	.6484E+04	.9819E+04	.1237E-01	.3198E+04	-.5020E+00	.1729E+00	.8474E+00
.1300E+03	.6470E+04	.9824E+04	.1634E-01	.3204E+04	-.4725E+00	.1638E+00	.8659E+00
.1600E+03	.6456E+04	.9829E+04	.2039E-01	.3210E+04	-.4457E+00	.1557E+00	.8816E+00
.1900E+03	.6443E+04	.9833E+04	.2452E-01	.3215E+04	-.4211E+00	.1484E+00	.8946E+00
.2200E+03	.6430E+04	.9838E+04	.2872E-01	.3221E+04	-.3986E+00	.1417E+00	.9061E+00
.2600E+03	.6415E+04	.9843E+04	.3440E-01	.3228E+04	-.3715E+00	.1339E+00	.9187E+00
.3000E+03	.6401E+04	.9849E+04	.4017E-01	.3235E+04	-.3472E+00	.1269E+00	.9292E+00
.3400E+03	.6387E+04	.9854E+04	.4601E-01	.3242E+04	-.3253E+00	.1206E+00	.9379E+00
.3800E+03	.6375E+04	.9858E+04	.5191E-01	.3249E+04	-.3054E+00	.1154E+00	.9452E+00
.4400E+03	.6357E+04	.9865E+04	.6055E-01	.3259E+04	-.2769E+00	.1084E+00	.9542E+00
.5000E+03	.6341E+04	.9871E+04	.6992E-01	.3268E+04	-.2556E+00	.1024E+00	.9614E+00
.6000E+03	.6317E+04	.9881E+04	.8516E-01	.3284E+04	-.2224E+00	.9446E-01	.9704E+00
.7000E+03	.6296E+04	.9890E+04	.1006E+00	.3298E+04	-.1944E+00	.8829E-01	.9769E+00
.8000E+03	.6278E+04	.9899E+04	.1162E+00	.3313E+04	-.1703E+00	.8347E-01	.9818E+00
.9000E+03	.6262E+04	.9907E+04	.1319E+00	.3326E+04	-.1492E+00	.7968E-01	.9856E+00
.1000E+04	.6245E+04	.9915E+04	.1477E+00	.3340E+04	-.1303E+00	.7672E-01	.9885E+00

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N O T I C E

ALL USERS

OPERATING SYSTEM CHANGE TO VERSION AL

VERSION AL OF THE SCOPE 3.3 OPERATING SYSTEM WILL BE INSTALLED MONDAY MAY 13 1974. VERSION AL MAKES MANDATORY MANY OF THE CONTROL CARD PARAMETERS WHICH WERE OPTIONAL UNDER VERSION AK. IN PARTICULAR THE FOLLOWING FEATURES WILL EFFECT THE USER-

1. DEFAULT MAP PARAMETER CHANGED FROM "ON" TO "PART".
2. USER ECS ON THE A MACHINE - 1450000.
3. USER ECS ON THE B MACHINE - 1170000.
4. PK PARAMETER IS REQUIRED ON JOB CARD OF JOBS USING PACKS. THE PK PARAMETER CONTAINS THE NO. OF PRIVATE PACKS USED BY THE JOB. A PACK JOB WILL NOT BE RUN EXPRESS.

   EXAMPLE - JOBNAME.CB50000,T200,MT1,PK2.

5. THE "DISPOSE" CARD, WHEN USED TO ROUTE THE FILE "OUTPUT" TO A SITE OTHER THAN THE ORIGINATION SITE, WILL RETURN A COPY OF THE DAYFILE TO THE ORIGINATION SITE.
6. RING STATUS MUST BE SPECIFIED ON "LABEL" CARDS USING THE "S" PARAMETER.

   EXAMPLE - LABEL,TAPE1,,,S=RING,,.
   OR
   LABEL,TAPE1,,,S=NORING,,,.

7. VOLUME SERIAL NUMBER (VSN) AND RING STAUS MUST BE SPECIFIED ON REQUEST CARDS.
   EXAMPLE - REQUEST,LFN,HY. (3523/RING)
   OR
   REQUEST,LFN,HI,L. (X32576/NORING)

   THE VSN AND RING STATUS MUST BE ENCLOSED IN PARENTHESIS BUT CAN BE PLACED ANYWHERE FOLLOWING THE PERIOD ON THE REQUEST CARD.

8. A MAXIMUM FIELD LENGTH WHICH CAN BE SPECIFIED ON THE JOB CARD IS DEFINED.
   MACHINE A - 300000B
   MACHINE B - 126000B (TEMPORARILY 130000B DUE TO LOADER)
9. USER IS PREVENTED FROM GAINING MORE MEMORY THAN IS SPECIFIED ON THE JOB CARD. RFL AND MEM WILL ABORT THE JOB WHEN MORE THAN THE JOB CARD FIELD LENGTH IS REQUESTED.
10. OPERATORS ARE PREVENTED FROM RERUNNING JOBS WHICH HAVE PRIVATE PACKS ATTACHED TO THEM. THIS PROTECTS THE INTEGRITY OF THE PRIVATE PACK.
11. A NEW PARAMETER HAS BEEN ADDED TO THE REQUEST CARD 'NR' (NO RECOVERY). IT SHOULD BE USED WHEN ATTEMPTING TO READ A TAPE WHICH IS KNOWN TO BE MARGINALLY RECORDED. WHEN ENCOUNTERING PARITY ERRORS ON THE TAPE THE SYSTEM WILL MAKE NO FURTHER ATTEMPT TO READ THE BAD RECORD. DATA WILL BE DELIVERED AS READ AND PARITY ERROR STATUS RETURNED TO THE PROGRAM. A DAYFILE MESSAGE WILL BE ISSUED FOR EACH PARITY ERROR.

```
  05/10/74  NADC REAL TIME SYS  VER AKJ 0 04/26/74
10.40.35.NSTTS5Z
10.40.35.NSTTS,T30.
10.40.35.CHARGE,VT1201.CARROLL X2012.
10.40.36.FTN(LR)
10.40.49.LGO.
10.41.01.NEWFL  14200
10.41.01.CP    003.454
10.41.01.PP    011.660
10.41.01.IO    000.930
10.41.04.STOP
10.41.04.MASS STORAGE  000151 PRU
10.41.04.CP       3.628 SEC.
10.41.04.PP      11.935 SEC.
10.41.04.IO        .940 SEC.
10.41.04.SEC     79.000 SEC.
                  NSTTS5Z  //// END OF LIST ////   EST62
```

45

LODNG70
LODNG70
LODNG70
LODNG70
LODNG70
LODNG70
LODNG70
LODNG70
LODNG70
LODNG70

```
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM  MMMMMMMMMMMMMMMM

      PROGRAM    LOONG                       CDC 6600 FTN V3.0-P336 OPT=1  06/11/76  11.12.28.      PAGE     1

            PROGRAM LOONG (INPUT,OUTPUT,TAPE6=OUTPUT)
            REAL MY,MZ,MX
            READ 1001,FL,AL,FSB,ASB
            WRITE(6,99)
      C
      C     CALCULATIONS OF MOMENT ARMS
      C
            CG=62.7
            XLA=AL-CG
            XLF=CG-FL
            XLBA=ASB-CG
            XLBF=CG-FSB
            BETA=21.5/57.296
      C     LOAD FACTORS TIMES WT OR MOMENT OF INERTIA
      C
            SB=1.00
            E1=0.
            CX=1.60
            H=1.20
            R=12.3
            XY=1085596./386.
            XZ=1079550./386.
            WT=1179.
      C
      C
            ALOADX=5006.
            ALOADY=618.
            ALOADZ=716.
            MX=-2563.
            XMM=-75255.
            XMN=-48556.
         10 READ 1002,A,B,C,D,E,L
            PX=A*WT+ALOADX
            PY=B*WT+ALOADY
            PZ=C*WT+ALOADZ
            MY=D*XY+XMM
            MZ=E*XZ+XMN
            IF(L.NE.0)GO TO 691
      C
      C
      C     TRIAL LUG REACTIONS
      C
            ARM=R+H-E1
            VBE=((PY*(R+H)-MX)*XLBA+SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
            VBB=((PY*(R+H)-MX)*XLBF-SB*MZ*ARM)/(ARM*(XLBF+XLBA)*TAN(BETA))
            VBF=ABS(VBE)
            VBA=ABS(VBB)
            RFPZ=(PC*(R+CX)-PZ*XLA-MY+VBF*(XLA+XLBF)-VBA*(XLBA-XLA))/(XLA+XLF)
            RAPZ=(MY-PX*(R+CX)-PZ*XLF+VBA*(XLF+XLBA)-VBF*(XLBF-XLF))/(XLA+XLF)
      C     TESTING FOR CASE TO BE USED
      C
            IF(RFPZ.GE.0.0.AND.RAPZ.GE.0.0) GO TO 21
            IF(RFPZ.GE.0.0.AND.RAPZ.LT.0.0) GO TO 27
            IF(RFPZ.LT.0.0.AND.RAPZ.GE.0.0) GO TO 38
            IF(RFPZ.LT.0.0.AND.RAPZ.LT.0.0) GO TO 49
```


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```
PROGRAM    LOONG                    CDC 6600 FTN V3.0-P336 OPT=1  06/11/74  11.12.28.      PAGE    2

C
C     LOADING CONDITIONS CAS 1
C
   21 RFZ=RFPZ
      RAZ=RAPZ
      IF(RFZ.GT.RAZ) GO TO 33
      RXA=PX
      RXF=0.0
      GO TO 34
   33 RXA=0.0
      RXF=PX
   34 CONTINUE
      RFY=((PY*E1-MX)*XLA-(1.0-S3)*MZ*ARM)/((XLF+XLA)*ARM)
      RFA=((PY*E1-MX)*XLF+(1.0-S3)*MZ*ARM)/((XLF+XLA)*ARM)
      IF(VBE) 6,8,8
    6 RBFMAX=0.0
      RBFMIN=VBF/COS(BETA)
      GO TO 9
    8 RBFMAX=VBF/COS(BETA)
      RBFMIN=0.0
    9 IF(VBB) 12,14,14
   12 RBAMAX=0.0
      RBAMIN=VBA/COS(BETA)
      GO TO 69
   14 RBAMAX=VBA/COS(BETA)
      RBAMIN=0.0
      GO TO 69
C
C     LOADING CONDITIONS CASE 2A
C
   27 RFZ=(PX*(R+CX)-PZ*XLBA-MY+VBF*(XLBA+XLBF))/(XLF+XLBA)
      RAZ=0.0
      RXF=PX
      RXA=0.0
      RFY=((PY*E1-MX)*XLA-(1.0-S3)*MZ*ARM)/((XLF+XLA)*ARM)
      RFA=((PY*E1-MX)*XLF+(1.0-S3)*MZ*ARM)/((XLF+XLA)*ARM)
      IF(VBE) 70,72,72
   70 RBFMIN=VBF/COS(BETA)
      RBFMAX=0.0
      GO TO 73
   72 RBFMAX=VBF/COS(BETA)
      RBFMIN=0.0
   73 IF(VBB) 74,76,76
   74 RBAMIN=(PZ*XLF+PX*(R+CX)-MY+VBF*(XLBF-XLF))/(2.*COS(BETA)*(XLF+XLB
     1A))+VBA/(2.*COS(BETA))
      RBAMAX=RBAMIN-VBA/COS(BETA)
      GO TO 69
   76 RBAMAX=(PZ*XLF+PX*(R+CX)-MY+VBF*(XLBF-XLF))/(2.*COS(BETA)*(XLF+XLB
     1A))+VBA/(2.*COS(BETA))
      RBAMIN=RBAMAX-VBA/COS(BETA)
      GO TO 69
C
C     LOADING CONDITION 2B
C
   38 RFZ=0.0
```

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```
PROGRAM    LOONG                        CDC 6600 FTN V3.0-P336 OPT=1  06/11/74  11.12.26.      PAGE    3
          RAZ=(MY-PX*(R+CX)-PZ*XLBF+V3)*(XLBA+XLBF))/(XLA+XLBF)
          RXF=0.0
          RXA=PX
          RFY=((PY*E1-MX)*XLA-(1.0-S3)*MZ*ARM)/((XLF+XLA)*ARM)
          RFA=((PY*E1-MX)*XLF+(1.0-S3)*MZ*ARM)/((XLF+XLA)*ARM)
          IF(VBE) 78,80,80
       78 RBFMIN=(PZ*XLA-PX*(R+CA)+MY+VBA*(XLBA-XLA))/(2.*COS(BETA)*(XLA+XLB
         1F))+VBF/(2.*COS(BETA))
          RBFMAX=RBFMIN-VBF/COS(BETA)
          GO TO 81
       80 RBFMAX=(PZ*XLA-PX*(R+CA)+MY+VBA*(XLBA-XLA))/(2.*COS(BETA)*(XLA+XLB
         1F))+VBF/(2.*COS(BETA))
          RBFMIN=RBFMAX-VBF/COS(BETA)
       81 IF(VBB) 82,84,84
       82 RBAMIN=VBA/COS(BETA)
          RBAMAX=0.0
          GO TO 63
       84 RBAMAX=VBA/COS(BETA)
          RBAMIN=0.0
          GO TO 63
C
C         LOADING CONDITION 3
C
       49 RFZ=0.0
          RAZ=0.0
          RXF=0.0
          RXA=PX
          RFY=((PY*E1-MX)*XLA-(1.0-S8)*MZ*ARM)/((XLF+XLA)*ARM)
          RFA=((PY*E1-MX)*XLF+(1.0-S8)*MZ*ARM)/((XLF+XLA)*ARM)
          IF (VBE) 86,88,48
       86 RBFMIN=(PZ*XLBA+MY-PX*(R+CX))/(2.*COS(BETA)*(XLBA+XLBF))+VBF/(2.*
         1COS(BETA))
          RBFMAX=RBFMIN-VBF/COS(BETA)
          GO TO 87
       88 RBFMAX=(PZ*XLBA+MY-PX*(R+CX))/(2.*COS(BETA)*(XLBA+XLBF))+VBF/(2.*
         1COS(BETA))
          RBFMIN=RBFMAX-VBF/COS(BETA)
       87 IF(VBB) 90,92,92
       90 RBAMIN=(PZ*XLBF-MY+PX*(R+CX))/(2.*COS(BETA)*(XLBA+XLBF))+VBA/(2.*
         1COS(BETA))
          RBAMAX=RBAMIN-VBA/COS(BETA)
          GO TO 63
       92 RBAMAX=(PZ*XLBF-MY+PX*(R+CX))/(2.*COS(BETA)*(XLBA+XLBF))+VBA/(2.*
         1COS(BETA))
          RBAMIN=RBAMAX-VBA/COS(BETA)
      69  WRITE(5,200)
          WRITE(6,201)
          WRITE(6,204) A,B,C,D,E
          WRITE(5,205)
          WRITE(6,206)
          WRITE(5,207)
          WRITE(5,208) RFZ,RAZ,RBFMAX,RBFMIN,RBAMAX,RBAMIN
          WRITE(5,214) RFY,RFA
          WRITE(6,215) RXF,RXA
          TSR=RBFMAX+RBAMIN
```


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```
      TSL=RBFMIN+RBAMAX
      TLL=RFZ+RAZ
      GO TO 10
  691 CONTINUE
   99 FORMAT(1H1)
 1001 FORMAT(4F10.2)
 1002 FORMAT(5F10.1,I10)
  200 FORMAT(51X,27H LOAD ANALYSIS MIL-A-8591 E,//)
  201 FORMAT(31X,29HNX     NY      NZ   THETA    PSI)
  204 FORMAT(5X,34H LOADING CONDITION  FLIGHT>TOW     ,30X,12HLOAD FACTOR
     1S.4X,5F7.2,/)
  205 FORMAT(56X,14HLOADING POINTS,//)
  206 FORMAT(12X,3HLUG,38X,17HFORWARD SWAY BRACE,24X,14HAFT SWAY BRACE,/)
  207 FORMAT(5X,* FORWARD    AFT*,32X,*LEFT           RIGHT*,21X,
     1*LEFT          RIGHT  *,/)
  208 FORMAT(2X,3H(Z),F7.0,2X,F7.0,20X,F7.0,7X,F7.0,19X,F7.0,7X,F7.0,/)
  214 FORMAT(2X,3H(Y),F7.0,2X,F7.0,/)
  215 FORMAT(2X,3H(X),F7.0,2X,F7.0,//)
      END
```


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```
PROGRAM    LOONG                                      CDC 6600 FTN V3.0-P336 OPT=1  08/11/76  11.12.28.      PAGE     5

           SYMBOLIC REFERENCE MAP

ENTRY POINTS
 4851   LOONG

VARIABLES      SN  TYPE            RELOCATION
 5151  A           REAL                               5123  AL        REAL
 5144  ALOADX      REAL                               5145  ALOADY    REAL
 5146  ALOADZ      REAL                               5162  ARM       REAL
 5125  ASB         REAL                               5152  B         REAL
 5133  BETA        REAL                               5153  C         REAL
 5126  CG          REAL                               5136  DX        REAL
 5154  D           REAL                               5155  E         REAL
 5135  E1          REAL                               5122  FL        REAL
 5124  FSB         REAL                               5137  H         REAL
 5150  L           INTEGER                            5121  MX        REAL
 5117  MY          REAL                               5120  MZ        REAL
 5157  PX          REAL                               5160  PY        REAL
 5161  PZ          REAL                               5140  R         REAL
 5170  RAPZ        REAL                               5172  RAZ       REAL
 5201  RBAMAX      REAL                               5202  RBAMIN    REAL
 5177  RBFMAX      REAL                               5200  RBFMIN    REAL
 5176  RFA         REAL                               5157  RFPZ      REAL
 5175  RFY         REAL                               5171  RFZ       REAL
 5173  RXA         REAL                               5174  RXF       REAL
 5134  SB          REAL                               5205  TLL       REAL
 5204  TSL         REAL                               5203  TSR       REAL
 5166  VBA         REAL                               5164  V3B       REAL
 5163  VBE         REAL                               5165  V3F       REAL
 5143  WT          REAL                               5127  XLA       REAL
 5131  XLBA        REAL                               5132  XLBF      REAL
 5130  XLF         REAL                               5147  XMM       REAL
 5150  XMN         REAL                               5141  XY        REAL
 5142  XZ          REAL

FILE NAMES         MODE
    0  INPUT        FMT         2022  OUTPUT                  2022  TAPE6       FMT

EXTERNALS           TYPE   ARGS
         COS        REAL      1 LIBRARY                   TAN       REAL      1 LIBRARY

INLINE FUNCTIONS    TYPE   ARGS
         ABS        REAL      1   INTRIN

STATEMENT LABELS
    0  6            INACTIVE          4313   8                            4316   9
 4125  10                                0  12       INACTIVE             4324  14
 4263  21                             4330  27                            4271  33
 4273  34                             4436  38                            4545  49
 4672  69                                0  70       INACTIVE             4363  72
 4366  73                                0  74       INACTIVE             4413  76
    0  78           INACTIVE          4510  50                            4533  81
    0  82           INACTIVE          4541  84                               0  86          INACTIVE
 4626  87                             4605  88                               0  90          INACTIVE
```

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```
        PROGRAM    LOONG                                    CDC 6600 FTN V3.0-P336 OPT=1  06/11/74  11.12.28.        PAGE      8

   STATEMENT LABELS
    4651  92                                  4774  99       FMT                         5003  200      FMT
    5010  201      FMT                        5015  204      FMT                         5025  205      FMT
    5031  206      FMT                        5040  207      FMT                         5050  208      FMT
    5057  214      FMT                        5063  215      FMT                         4772  691
    4776  1001     FMT                        5000  1032     FMT

   STATISTICS
     PROGRAM LENGTH    11428     610
      BUFFER LENGTH    40448    2084
```


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```
CORE MAP  11.12.52.  NORMAL            CONTROL                                    000100    013610    000000    000000
          ---TIME---LOAD MODE --L1--L2-----TYPE---------------USER--------CALL-------------FWA LOAD--LWA LOAD--BLNK COMN--LENGTH--
          FWA LOADER  043170  FWA TABLES  041250
          -PROGRAM----ADDRESS-                    --LABELED---COMMON----ADDRESS-
          LOONG       000100
          GETBA       005306
          SYSTEMS     005325
          INPUTCS     006337
          KODERS      006473
          KRAKERS     010107
          OUTPTCS     011634
          SINCOSE     011730
          TANE        012005
          SIOS        012101
          ----UNSATISFIED EXTERNALS-----                   REFERENCES
```

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LOAD ANALYSIS MIL-A-8591 E

LOADING CONDITION FLIGHT>TOW

LOAD FACTORS	NX	NY	NZ	THETA	PSI
	1.50	-.70	-2.00	-4.00	-2.00

LOADING POINTS

	LUG		FWARD SWAY BRACE		AFT SWAY BRACE	
	FORWARD	AFT	LEFT	RIGHT	LEFT	RIGHT
(Z)	15284.	222.	0.	7485.	7416.	0.
(Y)	289.	-20.				
(X)	7774.	0.				

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```
 06/11/76  NADC REAL TIME SYS  VER AL7 B 05789776
11.12.21.LOONG70
11.12.22.LOONG,CM20488,T10.
11.12.22.CHARGE,VT1201,CARROLL X2012.
11.12.28.FTN.
11.12.42.LGO.
11.12.53.NEWFL  13700
11.12.53.CP     003.080
11.12.53.PP     016.004
11.12.53.IO     000.050
11.12.54.END LOONG
11.12.54.MASS STORAGE  000120 PRJ
11.12.54.CP       3.905 SEC.
11.12.54.PP      16.217 SEC.
11.12.54.IO        .054 SEC.
11.12.54.SEC     30.000 SEC.
                  LOONG70  //// END OF LIST ////   ESTB2
```

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APPENDIX B

AERO 7A BOMB RACK ANALYSIS

APPENDIX B

This Appendix provides the results of investigation and analysis to define the strength envelope of the AERO-7A Bomb Ejector Rack.

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DOUGLAS AIRCRAFT CO
AERO 7A BOMB EJECTOR RACK - STRENGTH ENVELOPE

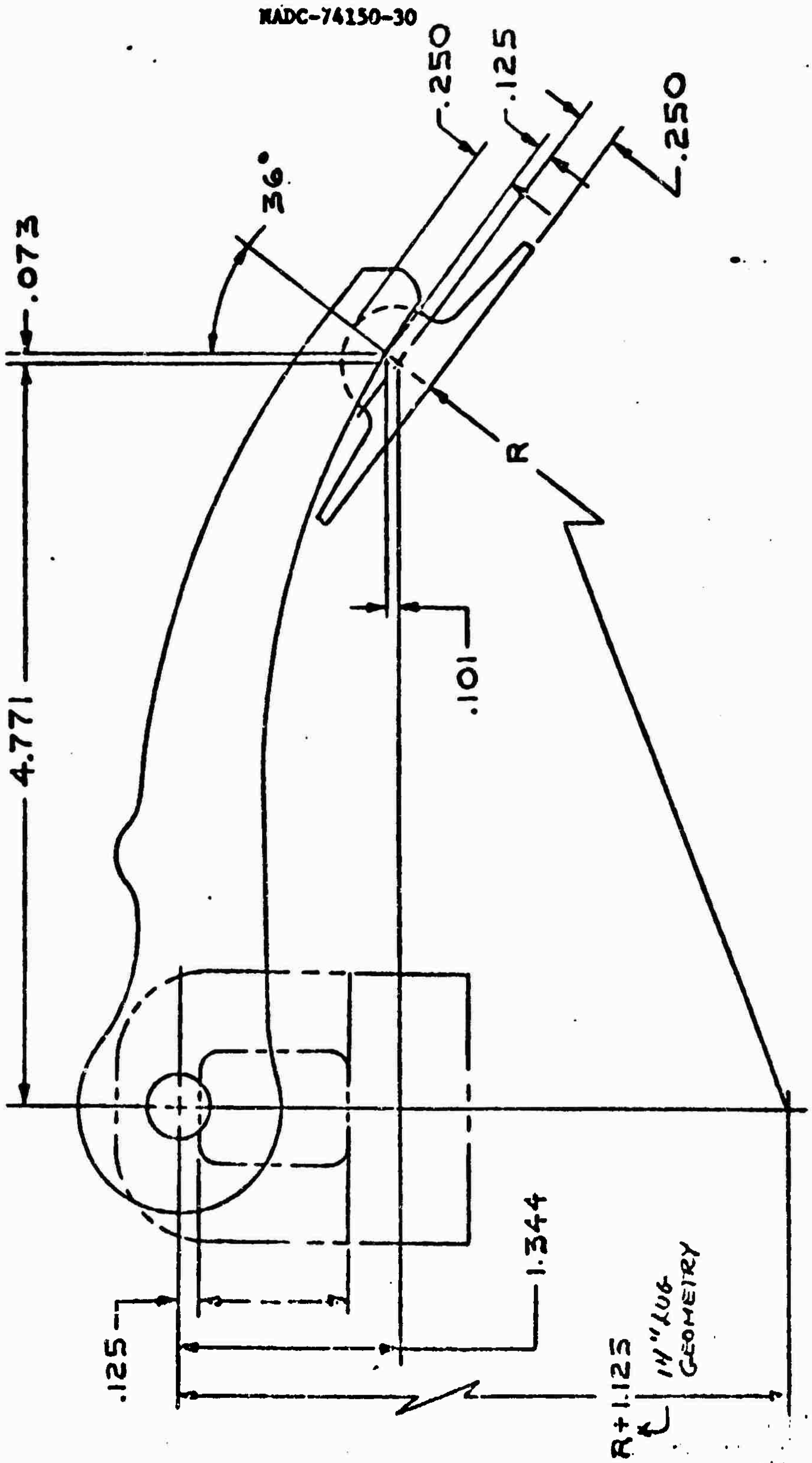
WILLIAM J. BOLLINGER
William J. Bollinger

5 JUNE, 1974

AERO 7A BOMB EJECTOR RACK ON THE A4 AIRCRAFT

STRENGTH SUMMARY:

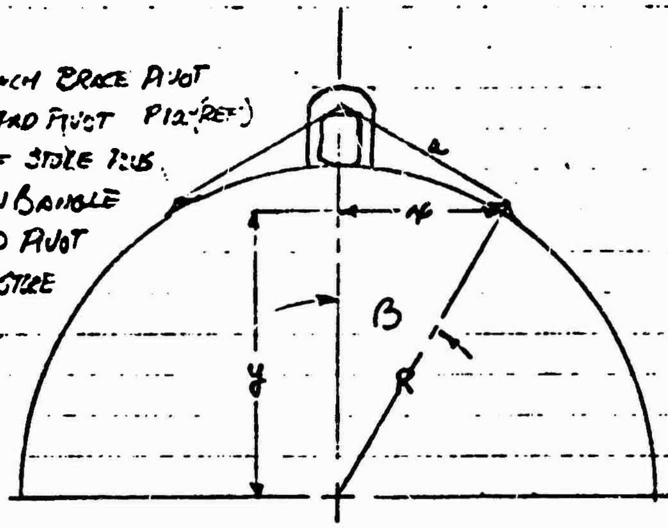
THIS REPORT ESTABLISHES THE STRENGTH ENVELOPE OF THE AERO 7A RACK BY INITIALLY CONVERTING THE MANUFACTURERS (DOUGLAS AIRCRAFT Co) STORE LOAD FACTORS INTO HOOK AND SWAY BRACE REACTION FOR COMPARISON WITH NAVAIRDEVCEN TEST RESULTS AND THE RACK SPECIFICATION TEST REQUIREMENTS. A METHOD IS SUBSEQUENTLY DERIVED BY STRESS ANALYSIS AND INTERPRETATION OF TEST DATA FOR MODIFYING THE DOUGLAS RECOMMENDATIONS TO MORE REALISTIC VALUES. THE ANALYSIS CONTAINED IN THIS REPORT IS SUMMARIZED AS FOLLOWS

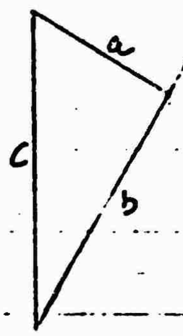

.250
.125
.250
36°
.073
4.771
R
.101
1.344
.125
R+1.125
1¼" LUG GEOMETRY

(1)

SWAY BRACE ANGLES - REF MAWHINNEY DERIVATION

a = DISTANCE FROM BRACE PIVOT TO BRACE PAD PIVOT P12 (REF)
b = RADIUS OF STORE PLUS DISTANCE ON BANGLE TO BRACE PAD PIVOT
c = RADIUS OF STORE PLUS VERTICAL DISTANCE TO BRACE PIVOT





a = 4.985
b = R + .250
c = R + c = R + 1.125

14" LUGS

$$\cos \beta = 1 - \frac{12.042}{R^2 + 1.375R + .2812}$$

30" LUGS

R + c = R + 1.50 + .06 = 1.56

STORE SURFACE TO BRACE PIVOT DISTANCE

MIL-A-8591D FIG 3 (30" LUG - 2000# WEIGHT CLASS - STORE SURFACE TO HOOK CONTACT POINT = 1.350 + 1.250 TAN 7° ± 5°

1.350 + 1.250 TAN 12° = 1.350 + .256 = 1.606

1.350 + 1.250 TAN 2° = 1.350 + .044 = 1.394

AVERAGE = 1.350 + (.256 + .044) ½ = 1.50

$$a^2 = b^2 + c^2 - 2bc \cos \beta$$

a = 4.985 (REF)

b = R + .250 (REF)

c = R + 1.50 + .063 = R + 1.56   .063 = HOOK BEARING SURFACE TO BRACE PIVOT (REF)

$$\overline{4.985}^2 = (R + .250)^2 + (R + 1.56)^2 - 2(R + .250)(R + 1.56) \cos \beta$$

$$24.850 = 2R^2 + 3.62R + 2.496 - (2R^2 + 3.62R + .78) \cos \beta$$

$$23.134 = 2R^2 + 3.62R + .78 - (2R^2 + 3.62R + .78) \cos \beta$$

$$\cos \beta = 1 - \frac{23.134}{2R^2 + 3.62R + .78} = 1 - \frac{11.567}{R^2 + 1.81R + .39}$$

SWAY BRACE ANGLES

(REF) DOUGLAS AIRCRAFT CO · STANDARD AIRCRAFT ARMAMENT CHARACTERISTICS - BOMB RACK EJECTOR - 4 HOOK - 7A - 3600 LB DATED 1 JULY 1955

(REF R-31) UPDATED NOV 1960 (TELECON JESS LOCKHART-DOUGLAS 5/7/74)

T63 STORE 30.5" DIA (14 INCH SUSPENSION) R = 15.25, W = 1700, C = 1.125

$$\cos B = 1 - \frac{12.042}{R^2 + 1.375R + .2812}$$

$$\cos B = 1 - \frac{12.042}{15.25^2 + 1.375 \times 15.25 + .2812}$$

$$\cos B = 1 - .04745 = .95255 \approx .95257$$

$B = 17° 43'$ $\tan B = .31946$ $\sin B = .30431$

T65 STORE 14.5" DIA (30 INCH SUSPENSION) R = 7.25", W = 3575, C = 1.56

$$\cos B = 1 - \frac{11.567}{R^2 + 1.81R + .39}$$

$$\cos B = 1 - .17507 = .82493 \approx .82495$$

$B = 34° - 25'$ $\tan B = .68514$ $\sin B = .56521$

T63 STORE

$x = R \sin B = 15.25 \times .30431 = 4.64$

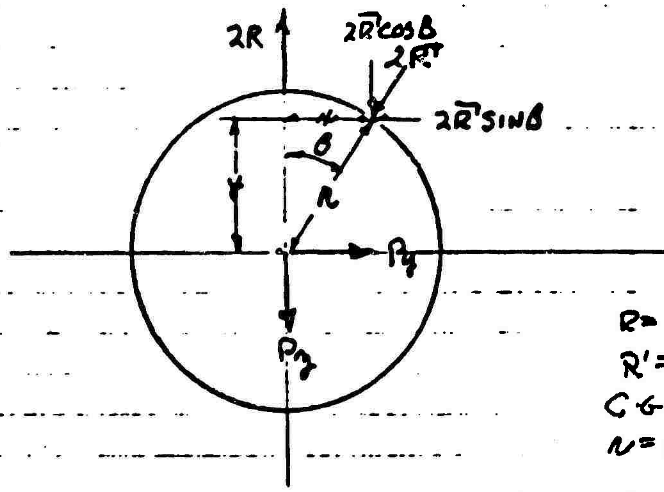
$y = R \cos B = 15.25 \times .95257 = 14.527$

T65 STORE

$x = 7.25 \times .56521 = 4.10$

$y = 7.25 \times .82495 = 5.98$

CHECKING HOOK AND BRACE REACTIONS AT POINTS GIVEN ON DOUGLAS STRENGTH ENVELOPE - REF



R = SINGLE HOOK LOAD
R' = SINGLE BRACE LOAD
C.G. = MIDPOINT BETWEEN LUGS
r = STORE RADIUS TO C

$$\uparrow \Sigma F_V = 2R - 2\bar{R}\cos\beta - P_z = 0$$
$$\curvearrowright \Sigma M_R = x \cdot 2\bar{R}\cos\beta + (r-y)\,2\bar{R}\sin\beta - r P_y = 0 \Big\}\ 2x\bar{R}\cos\beta = y P_y$$
$$\rightarrow \Sigma F_H = P_y - 2\bar{R}\sin\beta = 0$$

T63 STORE 30.5 DIA 1700 LBS 14 INCH SUSPENSION

① $n_z = 38.5$ $n_y = 0$ $n_x = 0$ $M_z = 100{,}000$ in# $\beta = 17°43'$

FOR THE 30.5" DIA STORE - ASSUME THAT THE BRACES ARE INEFFECTIVE IN YAW AND THAT ALL OF THE YAWING MOMENT IS REACTED AS SIDE LOAD ON THE HOOKS OR FRAME

$\bar{R} = 0$

$R = 19.25 \times 1700 = \underline{32{,}725}$#

② $n_z = 17.5$ $n_y = 6.8$ $n_x = 0$ $M_z = 100{,}000$ in# (HOOKS OR FRAME)

$$2x\bar{R}\cos\beta = yP_y$$
$$2 \times 4.64\,\bar{R}\cos\beta = 14.527 \times 6.8$$
$$\bar{R}\cos\beta = 10.644$$
$$\bar{R} = \frac{10.644}{\cos 17°43'} = \frac{10.644}{.95257} = 11.174$$

$$2R = 2\bar{R}\cos\beta + P_z$$
$$2R = 2 \times 10.644 + 17.5 = 38.788$$
$$R = 19.394 \times 1700 = \underline{32970}\#$$
$$\bar{R}_{max} = 11.174 \times 1700 = \underline{18995.8}\#$$

CHECKING HOOK AND BRACE REACTIONS AT POINTS GIVEN ON DOUGLAS STRENGTH ENVELOPE - REF (a) AERO 7A RACK STRENGTH CHARACTERISTICS.

(3) $n_z = 0$ $n_y = 6.8$ $n_x = 0$ $M_z = 100{,}000$ IN# (HOOKS OR FRAME)

$\bar{R}\cos\beta = 10.644$

$R'_{HCK} = 11.174 \times 1700 = \underline{18995.8}$#

$2R = 2 \times 10.644 + 0$

$R = 10.644 \times 1700 = \underline{18094.8}$

T65 STORE 14.5" DIA 3575 LBS 30 INCH SUSPENSION

(4) $n_z = 20.75$ $n_y = 0$ $n_x = 0$ $M_Y = 100{,}000$ IN# (HOOKS OR FRAME)

$\beta = 31°\,4'$

ASSUME THE HOOK LOAD CAN BE DERIVED SIMILARLY TO THE T63 STORE CASE IN WHICH NO YAWING MOMENT WAS REACTED BY THE BRACES AND CONSEQUENTLY THE HOOK LOAD WAS COMPUTED FROM THE MAXIMUM VERTICAL LOAD. THE SUM OF THE HOOK LOADS UNDER THE T63 STORE CASE ADD UP TO ($2 \times 32{,}970 = 65{,}450$) WHICH IS ABOUT EQUAL TO THE VALUE SPECIFIED AS THE YIELD LOAD UNDER THE OVERLOAD TEST IN MIL-R-22622 (AERO 7A RACK SPEC-ITEM 4.5.2). THIS VALUE CAN BE APPROXIMATELY DERIVED BY MULTIPLYING THE HOOK ULTIMATE LOAD BY FOUR (TWO HOOKS PER STATION) AND DIVIDING BY 1.5 AND MULTIPLYING BY 1.15 (SEE ITEM 4.4.3 OF SPEC)

14 INCH HOOK = $20{,}000 \times 4 \times \frac{1.15}{1.5} = 61{,}333 \approx 65{,}000$

30 INCH HOOK $25{,}000 \times 4 \times \frac{1.15}{1.5} = 76{,}666 \approx 74{,}000$

THIS CONCLUSION INDICATES THAT DOUGLAS CONSIDERED THE MAXIMUM ALLOWABLE HOOK LOAD AS HALF OF THE VALUE SPECIFIED FOR THE OVERLOAD TEST OR ABOUT 32,500# ON THE 14 INCH HOOKS. IT CAN ALSO BE CONCLUDED BY ANALOGY THAT THE VALUE SPECIFIED IN THE SPEC FOR THE 30 INCH HOOK UNDER THE OVERLOAD TEST IS ALSO A LIMIT ($74000/2 = 37{,}000$#). FOR THE ZERO SIDE, ZERO DRAG CASE ON THE T65 STORE, THE HOOK REACTION TO MAXIMUM DOWN LOAD IS $20.75/2 \times 3575 = \underline{37{,}090}$# THIS RESULT AGAIN ILLUSTRATES THAT DOUGLAS DID NOT CONSIDER ANY OF THE YAWING MOMENT TO BE REACTED BY THE BRACES, EVEN IN THE SMALL DIA STORE, BECAUSE THE VERTICAL COMPONENT OF THE BRACE LOAD WOULD HAVE TO ADD TO THE HOOK LOAD TO MAINTAIN EQUILIBRIUM IN WHICH CASE THE HOOK ALLOWABLE WOULD BE EXCEEDED.

CHECKING HOOK AND BRACE REACTIONS AT POINTS GIVEN ON DOUGLAS STRENGTH ENVELOPE REF (a).

TCS STORC:

(5) $n_z = 20.75$ $n_y = 0$ $n_x = 0$ $M_Y = 100{,}000$ in# $\beta = 31°4'$

IF ALL OF THE YAWING MOMENT WAS REACTED BY THE BRACES; THE FOLLOWING REACTIONS WOULD RESULT

$\bar{R}' \cos\beta = \frac{100{,}000}{20 \tan\beta} = 7300^{\#}$ BRACE VERTICAL COMPONENT

$R = \frac{n_z \times 3575}{2} + 7300 = \frac{20.75 \times 3575}{2} + 7300 = \underline{44{,}390}$

$\bar{R} = 7300/\cos\beta = 8550$

THIS HOOK IS IN EXCESS OF THE HOOK ULT LOAD RECOMMENDED BY DOUGLAS BUT DOES FALL WITHIN THE SPEC HOOK ULTIMATE LOAD ($25{,}000 \times 2 = 50{,}000^{\#}$ - MIL-R-22622 ITEM 4.4)

(6) $n_z = 11.5$ $n_y = 5.7$ $n_x = 0$ $M_z = 100{,}000$ (HOOKS OR FRAME)

$2 \times \bar{R} \cos\beta = y P_y$

$2 \times 4.10 \bar{R} \cos\beta = 5.98 \times 5.7$

$\bar{R}' \cos\beta = 4.16$

$\bar{R}' = \frac{4.160}{\cos 34°25'} = \frac{4.160}{.82495} = 5.043$

$2R = 2\bar{R}\cos\beta + P_y$

$R = 4.16 + 5.75 = 9.91$

$R = 9.91 \times 3575 = \underline{35428^{\#}}$

$\bar{R}' = 5.043 \times 3575 = \underline{18{,}029^{\#}}$

(7) $n_z = 0$ $n_y = 6.9$ $n_x = 0$ $M_z = 100{,}000$ (HOOKS OR FRAME)

$2 \times 4.10 \bar{R} \cos\beta = 5.98 \times 6.9$

$\bar{R} \cos\beta = 5.03$

$\bar{R} = \frac{5.03}{.82495} = 6.10$

$\bar{R}' = 6.10 \times 3575 = 21807$

$2R - 2 \times 5.03 = 0$

$R = 5.03$

$R = 5.03 \times 3575 = \underline{17{,}982}$

$2\bar{R}' \sin\beta = 2 \times 21807 \times .56521 = 24651 = 6.9 \times 3575$ ✓

6

CHECKING HOOK AND BRACE REACTIONS AT POINTS GIVEN ON DOUGLAS STRENGTH ENVELOPE (REF) DRAG CURVES

I63 STORE $W = 1700$ $\beta = 17°43'$ $N = 15.25$

⑧ $n_z = -32.5$ $n_x = \pm 5$ $n_y = 0$ $M_Z = \pm 100{,}000$ in# (HOOKS & FRAME)

USING MIL-A-8591D EQUATIONS. $N_{TC} = N + 1.125$

$\bar{Y}^f = 0$ $\bar{Y}^a = 0$

$$R_z^{f'} = \frac{5 \times 1700 \overbrace{(15.25 + 1.125)}^{16.375} + 32.5 \times 1700 \times 7}{14} = \frac{139187 + 386750}{14} = +37566$$

$$R_z^{a'} = \frac{-5 \times 1700 (15.25 + 1.125) + 32.5 \times 1700 \times 7}{14} = \frac{247563}{14} = +17683$$

$R_z^f = 37566$# $R_z^a = 17{,}683$#

$\bar{R}^f_{MAX} = 0$ $\bar{R}^a_{MAX} = 0$

⑨ $n_z = -11.5$ $n_y = +6.8$ $n_x = \pm 5$ $M_Z = \pm 100{,}000$ in# (HOOKS OR FRAME)

$$\bar{Y}^f = \frac{6.8 \times 10}{\tan 17°43' \times 20} = \frac{3.4}{.31946} = +10.64 \qquad \bar{Y}^a = \frac{6.8 \times 10}{.31946 \times 20} = +10.64$$

$$R_z^{f'} = \frac{+5 \times 1700 \times 16.375 + 11.5 \times 1700 \times 7 + 10.64 \times 1700 \times 17 - 10.64 \times 1700 \times 3}{14}$$

$$R_z^{f'} = \frac{139187 + 136{,}850 + 307{,}496 - 54{,}264}{14} = \frac{+529{,}269}{14} = +37{,}804$$

$$R_z^{a'} = \frac{-5 \times 1700 \times 16.375 + 11.5 \times 1700 \times 7 + 10.64 \times 1700 \times 17 - 10.64 \times 1700 \times 3}{14}$$

$$R_z^{a'} = \frac{-139{,}187 + 136{,}850 + 307{,}496 - 54{,}264}{14} = + \frac{250{,}895}{14} = +17921$$

$R_z^f = +37{,}804$ $R_z^a = +17921$

$$\bar{R}^f_{MAX} = +\frac{10.64}{\cos\beta} = \frac{10.64}{.95257} = 11.17$$

$$\bar{R}^f_{MAX} = \bar{R}^a_{MAX} = 11.17 \times 1700 = 18{,}989\#$$

CHECKING HOOK AND BRACE REACTIONS AT POINTS GIVEN ON DOUGLAS STRENGTH ENVELOPE REF (a) DRAG CURVES

T63 STORE

(10) $n_z = 0 \quad n_y = 5.3 \quad n_x = \pm 5 \quad M_z = \pm 100{,}000$ (HOOKS & FRAME)

$\bar{Y}^f = \dfrac{5.3 \times 10}{\tan 17°43' \times 20} = \dfrac{2.65}{.31946} = +8.29 \qquad \bar{Y}^a = \dfrac{5.3 \times 10}{.31946 \times 20} = +8.29$

$R_z^{f'} = \dfrac{5(16.375) + 8.29 \times 17 - 8.29 \times 3}{14} = \dfrac{81.75 + 140.93 - 24.87}{14} = +14.129$

$R_z^{a'} = \dfrac{-5(16.375) + 8.29 \times 17 - 8.29 \times 3}{14} = \dfrac{-81.75 + 140.93 - 24.87}{14} = +2.45$

$R_z^f = +14.129 \times 1700 = \underline{24{,}019} \qquad R_z^a = 2.45 \times 1700 = 4165$

$\bar{R}^f_{MAX} = \bar{R}^a_{MAX} = \dfrac{8.29 \times 1700}{.95257} = \underline{14{,}794}$#

T65 STORE

(11) $n_z = -17.5 \quad n_y = 0 \quad n_x = \pm 5 \quad M_z = 100{,}000$ in# (HOOKS OR FRAME)

$\beta = 31°4' \quad N = 7.25 \quad N_{TC} = 9.38 \quad W = 3575$

$\bar{Y}^f = 0 \qquad \bar{Y}^a = 0$

$R_z^{f'} = \dfrac{3575 \times 5 \times 8.81 + 3575 \times 17.5 \times 15}{30} = \dfrac{(44.05 + 262.5)3575}{30} = -36{,}530$#

$R_z^{a'} = \dfrac{-3575 \times 5 \times 8.81 + 3575 \times 17.5 \times 15}{30} = \dfrac{(218.6)3575}{30} = +26{,}032$

$\underline{\bar{R}^f_{MAX} = 0} \qquad \bar{R}^a_{MAX} = 0$

$R^f_z = -\underline{36{,}530} \qquad R^a_z = 26{,}032$

CHECKING HOOK AND BRACE REACTIONS AT POINTS GIVEN ON DOUGLAS STRENGTH ENVELOPE REF (a) ...... DRAG CURVES

T-65 STORE $\qquad R_{AC} = 7.25 + 1.56 = 8.81$

(12) $n_z = -7.87 \quad n_y = 6.1 \quad n_N = \pm 5 \quad M_Z = 100,000$ in# (HOOKS & FRAME)

$$\bar{V}^f = \frac{6.1 \times 10}{\tan 34°25' \times 20} = \frac{3.05}{.68514} = 4.45 \qquad \bar{V}^a = \frac{6.1 \times 10}{.68514 \times 20} = 4.45$$

$$R_2^{f'} = \frac{5 \times 8.81 \times 3575 + 7.87 \times 15 \times 3575 + 4.45 \times 25 \times 3575 - 4.45(-5) \times 3575}{30}$$

$$R_2^{f'} = \frac{157,479 + 422,028 + 397,719 + 79544}{30} = \frac{1,056,770}{30} = 35,225$$

$$R_2^{a'} = \frac{-5 \times 8.81 \times 3575 + 7.87 \times 15 \times 3575 + 4.45 \times 25 \times 3575 + 4.45(-5) \times 3575}{30}$$

$$R_2^{a'} = \frac{-157,479 + 422,028 + 397,719 + 79544}{30} = \frac{741,812}{30} = 24,727$$

$$\bar{R}^f_{MAX} = \bar{R}^a_{MAX} = \frac{4.45}{.82495} = 5.39 \times 3575 = \underline{19,269} \qquad \underline{R_2^f = 35,225} \quad \underline{R_2^a = 24,727}$$

(13) $n_z = -2.19 \quad n_y = 6.6 \quad n_N = \pm 5 \quad M_Z = 100,000$ in# (HOOKS & BRACES)

$$\bar{V}^f = \frac{6.6 \times 10}{.68514 \times 20} = 4.816 \qquad \bar{V}^a = 4.816$$

$$R_2^{f'} = \frac{5 \times 3575(8.81) + 2.19 \times 3575 \times 15 + 4.816 \times 3575 \times 25 - 4.816 \times 3575 \times (-5)}{30}$$

$$R_2^{f'} = \frac{157479 + 117435 + 430,430 + 86086}{30} = \frac{791,433}{30} = +26,381$$

$$R_2^{a'} = \frac{-157,479 + 117,435 + 430,430 + 86086}{30} = \frac{476,475}{30} = +15882$$

$$\bar{R}^f_{MAX} = \bar{R}^a_{MAX} = \frac{4.816}{.82495} \times 3575 = \underline{20,870}$$

$$R_2^f = \underline{26,381} \qquad R_2^a = 15,882$$

CHECKING HOOK AND BRACE REACTIONS AT POINTS GIVEN ON DOUGLAS STRENGTH ENVELOPE REF (a) DRAG CURVES.

T65 STORE

(14) $n_z = 0 \quad n_y = 5.7 \quad n_x = 5 \quad M_z = 5100{,}000 \text{ in}^{\#}$ (HOOKS AND FRAME)

$$\bar{V}^{f} = \frac{5.7 \times 10}{.68514 \times 20} = 4.16 \qquad \bar{V}^{a} = 4.16$$

$$R_z^{A'} = \frac{5 \times 8.81 \times 3575 + 4.16 \times 25 \times 3575 - 4.16 \times (-5) \times 3575}{30}$$

$$R_z^{f'} = \frac{157{,}479 + 371{,}800 + 74{,}360}{30} = \frac{603{,}639}{30} = 20{,}121$$

$$R_z^{a} = \frac{-157{,}479 + 371{,}800 + 74{,}360}{30} = \frac{288{,}681}{30} = 9{,}623$$

$$\bar{R}^{f}_{max} = \bar{R}^{a}_{max} = \frac{4.16}{.82495} \times 3575 = \underline{18{,}025}$$

$$R^{f}_{z} = \underline{20{,}121} \qquad R^{a}_{z} = 9{,}623$$

HOOK & BRACE LOAD SUMMARY AS DERIVED FROM REF a

COND	n_z	n_y	n_x	M_{xx}	T63-STORE (31.5 DIA) HOOK	T63-STORE (31.5 DIA) BRACE	T-65 STORE (14.5 DIA) HOOK	T-65 STORE (14.5 DIA) BRACE	CRITICAL
1	-38.5	0	0	0	32,725	0			14" HOOK
2	-17.5	+6.8	0	0	32,970	18,996			14" HOOK
3	0	+6.8	0	0	18,095	18996			BRACE
4	-20.75	0	0	0			37,090	0	30" HOOK
5	-20.75	0	0	100,000			44,390	8850	—
6	-11.5	+5.7	0	0			35,428	18,029	30" HOOK
7	0	+6.9	0	0			17,982	21,811	BRACE
8	-32.5	0	+5	0	37,566	0			14" HOOK
9	-11.5	+6.8	+5	0	37,814	18,959			14" HOOK
10	0	+5.3	+5	0	24,019	14,794			—
11	-17.5	0	+5	0			36,530	0	30" HOOK
12	-7.57	+6.1	+5	0			35,225	19,269	30" HOOK
13	-2.19	+6.6	+5	0			26,381	20,870	BRACE
14	0	+5.7	+5	0			20,121	18,025	—

CONCLUSIONS FROM CHECK OF DOUGLAS STRENGTH ENVELOPE (REF a,

DEFINITIONS FROM MIL-T-7743

LIMIT LOAD - THE MAXIMUM LOAD ANTICIPATED DURING NORMAL CONDITIONS OF OPERATION.

YIELD LOAD - 1.15 x LIMIT LOAD. DEFORMATIONS REMAINING AFTER APPLICATION OF THE YIELD LOAD SHALL NOT ADVERSELY AFFECT EITHER THE AERODYNAMIC CHARACTERISTIC OR MECHANICAL OPERATION OF THE RACK

ULTIMATE LOAD 1.50 x LIMIT LOAD FAILURE SHALL NOT OCCUR AT THIS LOAD LEVEL.

THE FOREGOING ANALYSIS OF THE DOUGLAS AERO 7A BOMB RACK PRODUCED THE FOLLOWING ULTIMATE LOADS.

MAXIMUM BRACE LOAD = 21,807#

MAXIMUM 14" HOOK STATION LOAD = 37,804#

MAXIMUM 30" HOOK STATION LOAD = 37,090#

MAXIMUM YAWING MOMENT = 100,000 INCH-LBS.

HOOK LIMITS - AS A MEAN OF CHECKING THESE VALUES, LIMITING HOOK STATION LOADS WERE DERIVED FROM THE AERO 7A RACK SPEC (MIL-R-22622) OVERLOAD RACK AND ULTIMATE HOOK TESTS. THE OVERLOAD TEST IS CONDUCTED ON RANDOMLY SELECTED SAMPLES OF PRODUCTION RACKS BY APPLYING THE FOLLOWING SPECIFIED DOWN LOADS TO THE COMPLETE RACK STRUCTURE

30 INCH HOOKS - 74,000# (YIELD LOAD) = 37000# PER HOOK STATION

14 INCH HOOKS = 65,000# (YIELD LOAD) = 32,500# PER HOOK STATION

THE HOOK ULTIMATE LOAD TEST IS CONDUCTED BY SUBJECTING INDIVIDUAL HOOKS TO THE FOLLOWING MINIMUM DOWN LOADS AND CONTINUING THE TEST UNTIL THE HOOK FAILS.

30 INCH HOOK = 25,000# MINIMUM

14 INCH HOOK = 20,000# MINIMUM.

EACH HOOK STATION ON THE AERO 7A RACK CONTAINS TWO HOOKS WHICH OPEN IN OPPOSSING DIRECTIONS. THE HOOK ULTIMATE LOAD TEST IS CONDUCTED BY APPLYING THE LOADS AT APPROXIMATELY THE TIP OF ONE OF THESE HOOKS. DURING ACTUAL CARRIAGE OF A STORE, THE LUG IS SO CONFINED BY THE RACK FRAME AS TO ASSURE NEARLY EQUAL SHARING OF THE TOTAL LUG LOAD BETWEEN THE HOOKS.

DERIVING THE ULTIMATE HOOK STATION DOWN STRENGTH FROM THE OVERLOAD TEST, WHICH IS THE MOST REALISTIC

CONCLUSIONS FROM CHECK OF DOUGLAS STRENGTH ENVELOPE REFa,

OF THE SPEC TESTS, PRODUCES THE FOLLOWING RESULTS.

30 INCH HOOK STATION = $37000 \times \frac{1.5}{1.15}$ = 48,260#

14 INCH HOOK STATION = $32,500 \times \frac{1.5}{1.15}$ = 42,390#

HOWEVER, SINCE THE HOOKS ARE ALSO SUBJECTED TO A SIDE LOAD WHICH IS NOT CONSIDERED IN THE SPEC. TESTS, THE MORE CONSERVATIVE DOWN LOADS FROM THE DOUGLAS STRENGTH ENVELOPE WILL BE ACCEPTED ≈ 37,000#.

BRACE LIMITS — THE BRACE LOADS DERIVED FROM THE DOUGLAS STRENGTH ENVELOPE ARE GREATLY IN EXCESS OF THOSE DEMONSTRATED BY NADC LABORATORY TESTING OF THE AERO 7A RACK AS REPORTED IN NADC REPORT NADC-AM-6739 OF 20 NOV 1967 — "UPGRADING OF THE AERO 7A EJECTOR BOMB RACK FOR THE A6-A AIRCRAFT. THESE TESTS WERE PLANNED TO SUBJECT THE SWAY BRACES TO FAILURE LOADS BY IMPOSING INCREASING INCREMENTS OF SIDE LOAD ON A MER BEAM CONFIGURATION. BRACE FAILURE OF THE UNMODIFIED RACK OCCURED AT 8500 LBS SIDE LOAD WHICH WAS RESOLVED BY ANALYSIS INTO A 7,438 LB SWAY BRACE RESULTANT REACTION. HOWEVER, THE ASSUMPTION USED IN CALCULATING THIS BRACE REACTION (2/3 OF THE SIDE LOAD REACTED AT THE BRACES AND 1/3 AT THE HOOKS) WAS FOUND TO BE CONSERVATIVE. CONSEQUENTLY, THE BRACE FAILURE LOAD WILL BE ADJUSTED IN THIS REPORT BY WHAT IS CONSIDERED TO BE A MORE REALISTIC ANALYSIS.

TEST SET-UP DIMENSIONS AND ANGLES WERE TAKEN FROM NOTES RECORDED BY CARL ACKER DURING THE TESTING INDICATED IN THE REPORT.

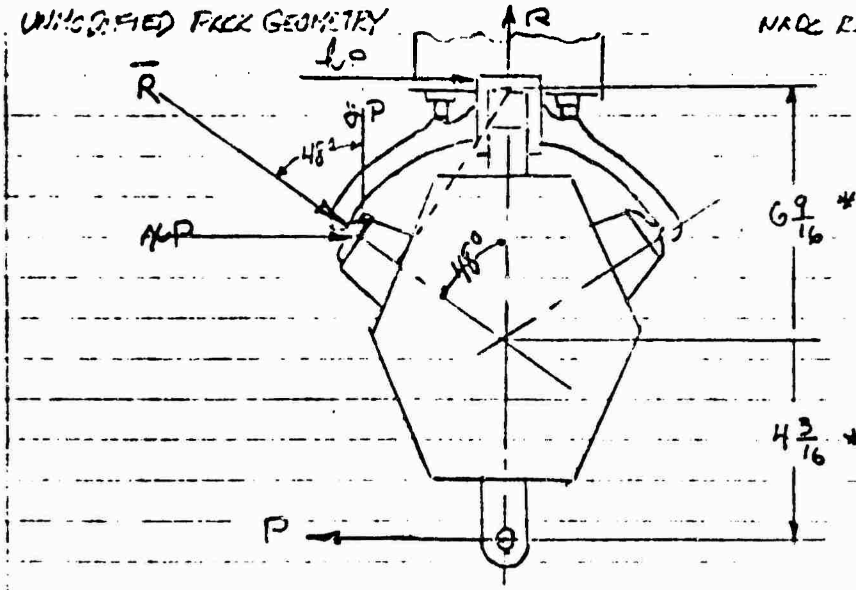
CONCLUSIONS FROM CHECK ON DOUGLAS STRENGTH ENVELOPE

BRACE LIMITS

NADC TEST SET-UP - MER BEAM ON AN UNMODIFIED AERO 7A RACK

UNMODIFIED RACK GEOMETRY

NADC REPORT # NADC-AM-6739(C)



$\cos 48° = .66913$

$\sin 48° = .74314$

$\tan 48° = 1.1106$

BOTH BRACES ACTING AS SHOWN.

* NATE FIX THESE DIMENSIONS CHANGE TO $6\frac{5}{16}$ & $4\frac{7}{16}$ RESPECTIVELY. $\beta = 48°$

$$\overset{\frown}{\Sigma} M_{\text{HOOK BEARING SURFACE}} = 10.75P - \frac{\mu P}{\sin\beta} \times 6.562 \sin\beta = 0$$

$$\mu = 1.638$$

$$\overset{+}{\rightarrow}\Sigma F_H = \ell P + \mu P - P = 0$$

$$\ell P + 1.638P - P = 0 \qquad \ell = -.638$$

$$\uparrow \Sigma F_V \quad R - yP = R - \frac{\mu P}{\tan\beta} = 0 \qquad R - \frac{1.638P}{1.1106} = 0 \qquad R = 1.475P$$

$$\bar{R} = \frac{\mu P}{\sin\beta} = \frac{1.638P}{.74314} = 2.204P$$

$$\bar{R}_{\text{PER BRACE}} = \tfrac{1}{2} \times 2.204P = 1.102P$$

AT THE FAILING SIDE LOAD OF 8500#

$\bar{R}$ PER BRACE $= 1.102 \times 8500 = 9367$#

SINCE ULTIMATE LOAD IS DEFINED AT THE POINT JUST BEFORE FAILURE OCCURS, LET THE BRACE ULTIMATE LOAD = 9000#

CONCLUSIONS FROM CHECK ON DOUGLAS STRENGTH ENVELOPE BRACE LIMITS

RECALCULATING SWAY BRACE LOADS IN NADC REPORT NADC-AM-6739 EQUATIONS FOR NATC FIX (LARGE DIA STORE)

$$\Sigma M_{\text{HOOK BEARING SURFACE}} = 10.75P - \frac{\mu P}{\sin\beta} \times 6.3125 \sin\beta = 0$$

$$\mu = 1.703$$

$$\overrightarrow{\Sigma F_H} = \lambda P + \mu P - P = 0$$

$$\lambda = .703$$

$$\uparrow \Sigma F_V : R - \gamma P = R - \frac{\mu P}{\tan\beta} = R - \frac{1.703P}{1.1106} = 0 \qquad R = 1.533P$$

$$\bar{R} = \frac{\mu P}{\sin\beta} = \frac{1.703P}{.74314} = 2.292P$$

$$\bar{R}_{\text{PER BRACE}} = \tfrac{1}{2}\bar{R} = 1.146P$$

	UNMODIFIED RACK TABLE I-(REF)		NATC FIX TABLE III-(REF)		
TOTAL SIDE LOAD	SWAY BRACE LOAD $\bar{R} = 1.102P$	DEFLECTION BRACE TO FRAME FWD END	SWAY BRACE LOAD $\bar{R} = 1.146P$	DEFLECTION BRACE TO FRAME FWD END	
0	0	0	0	0	
1000	1102	.012	1146	.018	
2000	2204	.043	2292	.051	DERIVED FROM CURVES FIG 6 NADC-AM-6739
3000	3306	.075	3438	.084	
4000	4408	.110	4584	.119	
5000	5510	.151	5730	.150	
6000	6612	.205	6876	.185	
7000	7714	.266	8022	.217	
8000	8816	.364	9168	.258	
UNMODIFIED FAILURE → 8500	9367		10,314	.356	IN DEFLECTION DATA
NATC FIX FAILURE 14750		FAILURE →	16,903		

FOR A LARGE DIAMETER STORE ACT ULTIMATE BRACE LOAD = 16,500#

THE UNMODIFIED RACK REPRESENTS A SMALL DIAMETER STORE

THE NATC FIX REPRESENTS A LARGE DIAMETER STORE

FOR A SMALL DIAMETER STORE ACT ULTIMATE BRACE LOAD = 9000#

AS CAN BE OBSERVED FROM THE DATA THE FAILURE LOAD FOR THE NATC FIX REPRESENTING A LARGE DIA STORE IS CONSIDERABLY LARGER THAN THE FAILURE LOAD FOR THE SMALL DIAMETER STORE (UNMODIFIED RACK DATA).

CONCLUSIONS FROM CHECK ON DOUGLAS STRENGTH ENVELOPE
HOOK SIDE LOAD LIMITS

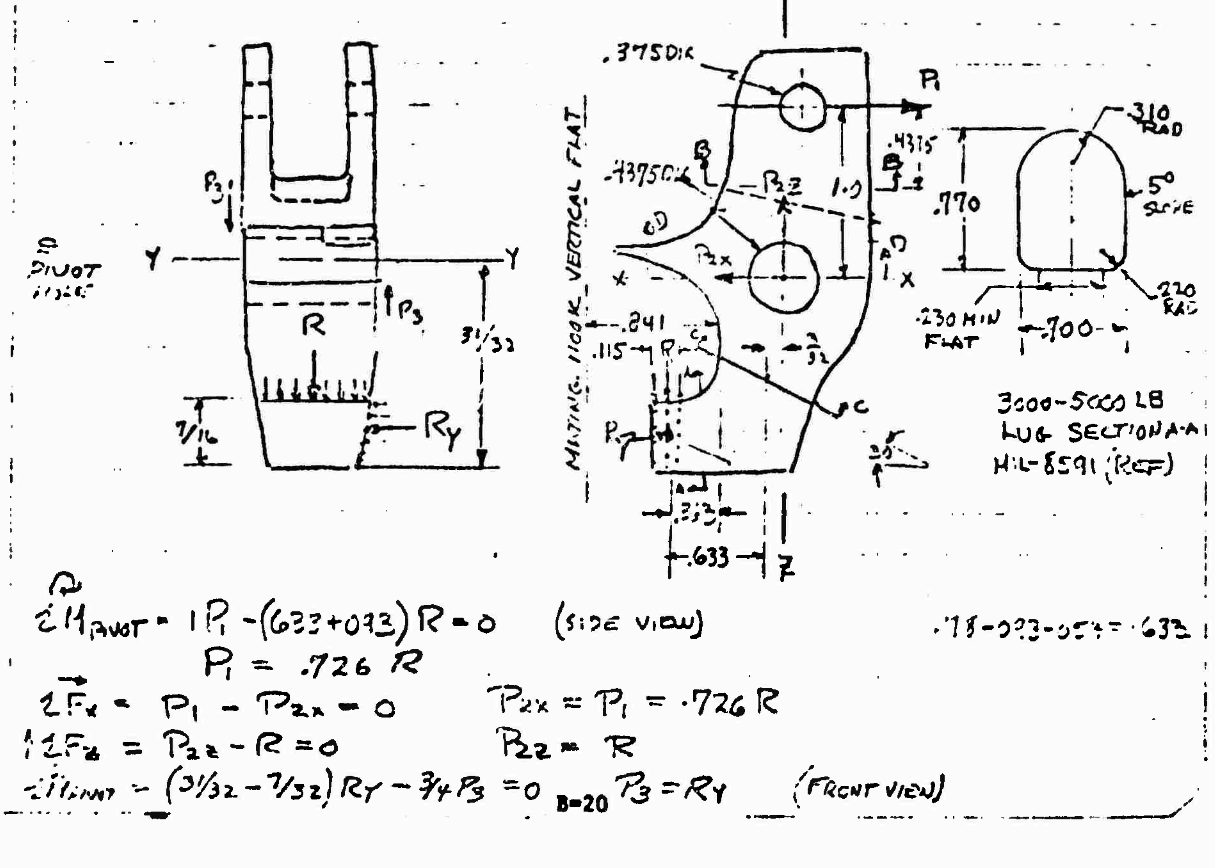
THE BRACE LOADS COMPUTED FROM THE DOUGLAS STRENGTH ENVELOPE WERE OF SUCH HIGH MAGNITUDE, WITHOUT CONSIDERING YAWING MOMENT, THAT IT BECAME APPARENT THAT YAWING MOMENT WAS REACTED BY SIDE LOADS ON THE HOOKS. BECAUSE OF THE LACK OF CONFIDENCE ESTABLISHED IN THE DOUGLAS ANALYSIS DUE TO THE UNREALISTICALLY HIGH BRACE LOADS, THE QUESTION ARISES AS TO THE STRUCTURAL ADEQUACY OF THE HOOKS TO REACT THIS SIDE LOAD IN ADDITION TO THE HIGH ... LOAD ALREADY IMPOSED IN THE STRENGTH ENVELOPE. SINCE NO TEST DATA IS AVAILABLE TO DEMONSTRATE THAT THE HOOKS CAN WITHSTAND THE SIDE LOAD IMPOSED BY THE SPECIFIED 100,000 IN-# OF YAWING MOMENT, STRESS ANALYSIS OF THE HOOK WILL BE USED TO APPROXIMATE HOOK CAPABILITY.

THE 14 INCH HOOKS ARE NOT CONSIDERED IN THIS ANALYSIS.

30 INCH HOOKS

ALL DIMENSIONS ARE APPROXIMATE - SCALED FROM HOOK

LOAD POSITION ON HOOK = .78 FROM PIVOT (MIL-R-22622)



$\Sigma M_{PIVOT} = 1P_1 - (.633+.093)R = 0$ (SIDE VIEW)

.78 - .093 - .054 = .633

$P_1 = .726\,R$

$\Sigma F_x = P_1 - P_{2x} = 0 \qquad P_{2x} = P_1 = .726\,R$

$\Sigma F_z = P_{2z} - R = 0 \qquad P_{2z} = R$

$\Sigma M_{PIVOT} = (31/32 - 7/32)R_Y - 3/4\,P_3 = 0 \qquad P_3 = R_Y$ (FRONT VIEW)

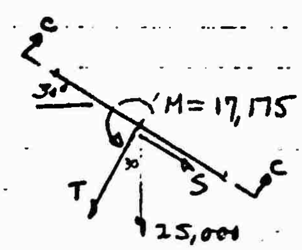
CONCLUSIONS FROM CHECK ON DOUGLAS STRENGTH ENVELOPE
HOOK SIDE LOAD LIMITS

CHECKING HOOK ULTIMATE STRENGTH AT CRITICAL SECTION C-C (P13-REF) BASED ON SPEC MIL-R-22622 ULTIMATE LOAD TEST VALUES.

30" HOOKS — 25,000 MINIMUM LOAD PER HOOK APPLIED AT A POINT .78 FROM THE HOOK PIVOT.

DISTANCE TO CENTROID OF SECTION FROM LOAD = .78 - .093 = .687

$M_{cc} = .687 \times 25000 = 17,175$ (ULT)

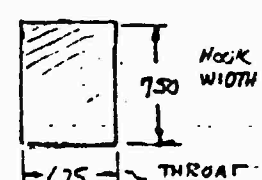


$T = 25,000 \cos 30° = 25000 \times .866 = 21650$

$S = 25,000 \sin 30° = 25000 \times .500 = 12,500$

$I_{YY} = \frac{1}{12} b h^3 = \frac{1}{12} \times .750 \times \overline{.625}^3 = .0152$

$f_{bu} = \frac{17175 \times .3125}{.0152} = 353,104$



SECTION C-C

INTRODUCE A FORM FACTOR OF 1.5 TO ACCOUNT FOR REDISTRIBUTION OF BENDING STRESS DUE TO PLASTICITY

$f_{bu} = 353,104 \times \frac{1}{1.5} = 235,402$

$f_{tu} = \frac{21,650}{.750 \times .625} = 46,186$ $\qquad f_{su} = \frac{12500}{.625 \times .750} = 26,666$

$f_{s\,MAX} = \sqrt{f_s^2 + (f_n/2)^2} = \sqrt{26,666^2 + \left(\frac{235,402 + 46,186}{2}\right)^2} = 143,300$

$f_{n\,MAX} = \frac{f_n}{2} + f_{s\,MAX} = \frac{235,402 + 46,186}{2} + 143,300 = 284094$ psi

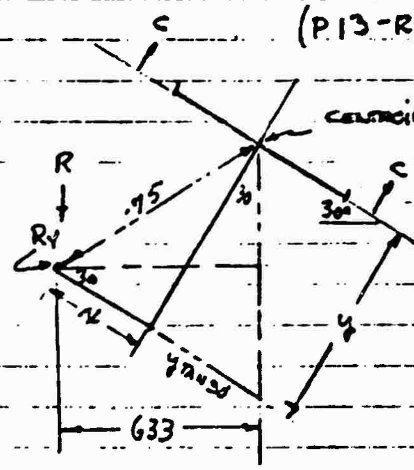
RANDOMLY SELECTED PRODUCTION RACKS ARE SUBJECTED TO THIS LOAD AND MOMENT, AND REQUIRED TO SUSTAIN THEM AS A MINIMUM. OBVIOUSLY, HOWEVER THE COMPUTED STRESS IS IN EXCESS OF THE ULTIMATE STRENGTH OF THE MATERIAL (180,000 psi). PRESTRESSING OF THE HOOKS PRIOR TO TEST COULD CONCEIVABLY ACCOUNT FOR THE DIFFERENCE; CONSEQUENTLY THESE COMPUTED ULTIMATE STRESSES WILL BE USED AS REFERENCE STRESSES IN EVALUATING HOOK STRENGTH.

CONCLUSION FROM CHECK ON DOUGLAS STRENGTH ENVELOPE

HOOK SIDE LOAD LIMITS

SIDE LOAD MOMENT ARMS

(P13-REF)



$(x + y \tan 30) \cos 30 = .633$

$x^2 + y^2 = .75^2$

$.866x + .5y = .633$

$x + .577y - .730 = 0$

$(.730 - .577y)^2 + y^2 = .75^2$

$.533 - .842y + .333y^2 + y^2 = .5625$

$1.333y^2 - .842y - .0295 = 0$

$y^2 - .6316y - .022 = 0$

$y = \dfrac{+.6316 \pm \sqrt{.3989 + .088}}{2} = \dfrac{.6316 + .6978}{2} = .6647$

$x = .730 - .577 \times .6647 = .3465$

CHECKING SECTION C-C FOR WORST HOOK LOAD P.9 (REF)

T-65 STORE 30" HOOKS

HOOK DOWN LOAD PER STATION = 37,090# (ULT) SINGLE HOOK DOWN LOAD = 18,545#

HOOK SIDE LOAD PER STATION = STORE YAWING MOMENT / HOOK SPACING

= 100,000/30 = 3333# (ULT) (DOUGLAS STRENGTH ENVELOPE)

SINGLE HOOK SIDE LOAD = 1666# (ULT)

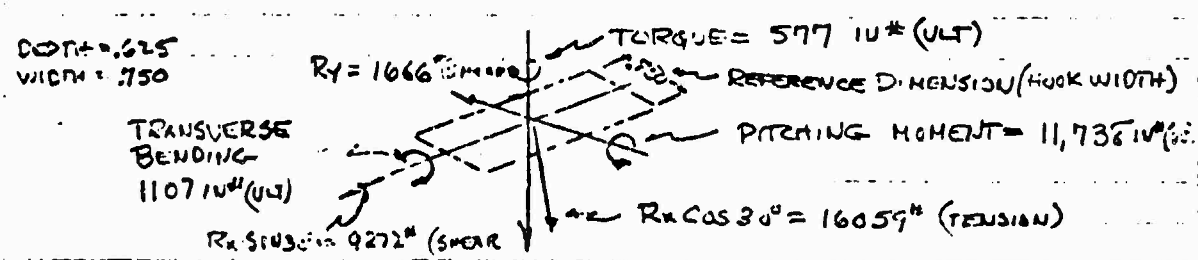
PITCHING MOMENT ON SECTION C-C = .633 × 18,545 = 11,738 IN-# (ULT) = MYY

TORQUE ON SECTION C-C = RY × x = 1666 × .3465 = 577 in# (ULT)

TRANSVERSE BENDING ON SECTION CC = RY × y = 1666 × .6647 = 1107 IN# (ULT)

TENSION COMPONENT OF DOWN LOAD = Rx COS 30 = 18545 × .866 = 16,059

SHEAR COMPONENT OF DOWN LOAD = Rx SIN 30 = 18545 × .500 = 9272



LOADS & MOMENTS ON SECTION C-C

CONCLUSIONS FROM CHECK ON DOUGLAS STRENGTH ENVELOPE HOOK SIDE LOAD LIMITS

$$f_{bu} = \frac{M_{YY}C}{1.5 \times I_{YY}} + \frac{M_{ZZ}C}{1.5 \times I_{XX}} + \frac{R_2 \cos 30^\circ}{bh}$$

1.5 = FORM FACTOR RECTANGULAR SECTION

$$f_{su} = \frac{\text{TORQUE}}{\alpha b h^2} + \frac{R_Y}{bh} + \frac{R \sin 30}{bh}$$

REFERENCE - ADVANCED MECHANICS OF MATERIAL SEELY-SMITH-2ND ED.

$$f_{bu} = \frac{11,738 \times .312}{\frac{1}{12} \times .75 \times .625^3 \times 1.5} + \frac{1107 \times .375}{\frac{1}{12} \times .625 \times .750^3} + \frac{16059}{.625 \times .750}$$

$$f_{bu} = \frac{3662}{.0152 \times 1.5} + \frac{415}{.022 \times 1.5} + \frac{16059}{.46} = 160625 + 12575 + 34910$$

$$f_{bu} = 208,110$$

$$f_{su} = \frac{577}{.208 \times .75 \times .625^2} + \frac{1666}{.625 \times .75} + \frac{9272}{.625 \times .75} = \frac{577}{.061} + \frac{10938}{.46}$$

$$f_{su} = 9459 + 23778 = 33,237$$

$$f_{s\,MAX} = \sqrt{33.3 \times 10^3{}^2 + \left(\frac{208}{2} \times 10^3\right)^2} \; 10^3\sqrt{1109 + 10816} = 109,200 \text{ psi}$$

$$f_{n\,MAX} = \frac{208,110}{2} + 109,200 = 213,255$$

THESE STRESSES INDICATE A REASONABLE MARGIN WHEN COMPARED TO THE REFERENCE STRESSES COMPUTED ON PAGE 14. HOWEVER, DUE TO THE UNCERTAINTY OF THE HOOK DIMENSIONS AND THE RELUCTANCE TO RELY ON THE PRESTRESS, WHICH IS REALLY INTENDED TO PROLONG FATIGUE LIFE, IT IS RECOMMENDED THAT THE HOOK LOADS BE LIMITED TO THOSE WITHIN THE ULTIMATE TENSILE AND SHEAR STRENGTHS OF THE MATERIAL. THIS CAN BE ACHIEVED BY DECREASING THE HOOK DOWNLOAD. THE BENDING STRENGTH IS MODIFIED BY A FORM FACTOR TO INTRODUCE THE TRAPIZOIDAL DISTRIBUTION OF STRESS WHICH IS ALLOWABLE BEYOND THE ELASTIC LIMIT.

F_{tu} = 180,000 psi F_{su} = 106,000 DOUGLAS DWG #4430645 (REF).

CONCLUSIONS FROM CHECK ON DOUGLAS STRENGTH ENVELOPE
HOOK SIDE LOAD LIMITS:

ASSUME HOOK DOWN LOAD PER STATION = 30,000# (ULT)
SINGLE HOOK DOWN LOAD = 15,000# (ULT)
HOOK SIDE LOAD PER STATION = 3333# (ULT)
SINGLE HOOK SIDE LOAD = 1666# (ULT)

PITCHING MOMENT = $\cdot 633 \times 15000 = 9495$
$R_x \cos 30° = 15000 \times \cdot 866 = 12990$
$R_x \sin 30° = 15000 \times \cdot 500 = 7500$

$$f_{bu} = \frac{9495 \times \cdot 312}{\cdot 0152 \times 1\cdot 5} + \frac{1107 \times \cdot 375}{\cdot 022 \times 1\cdot 5} + \frac{12990}{\cdot 46}$$

$$f_{bu} = 129{,}932 + 12575 + 28239 = 170{,}746 \text{ psi}$$

$$f_{su} = \frac{577}{\cdot 061} + \frac{1663}{\cdot 46} + \frac{7500}{\cdot 46}$$

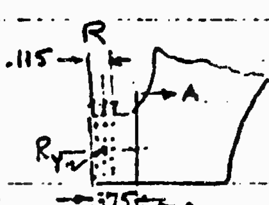
$$f_{su} = 9459 + 19926 = 29{,}385 \text{ psi}$$

$$f_{s\,MAX} = \sqrt{(29\cdot 4 \times 10^3)^2 + \left(\frac{171}{2} \times 10^3\right)^2} = 10^3\sqrt{864 + 7310} = 90{,}410 \text{ psi}$$

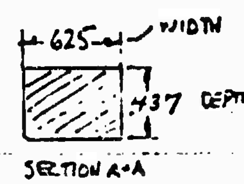
$$f_{n\,MAX} = \frac{171{,}000}{2} + 90{,}410 = 175{,}910 \text{ psi}$$

$$M.S = \frac{180}{175\cdot 9} - 1 = +.02$$

SECTION A-A REF P-13
PITCHING MOMENT = $R(\cdot 375 - \frac{\cdot 115}{2}) = \cdot 3175 R$
$= \cdot 3175 \times 15000 = 4763$ in# (ULT)



TRANSVERSE MOMENT = $\cdot 3175 \times R_Y = \cdot 3175 \times 1666 = 529$ in# (ULT)
TORQUE = 0



$$f_{bu} = \frac{4763 \times \cdot 2185}{1/12 \times \cdot 625 \times \overline{\cdot 437}^3 \times 1\cdot 5} + \frac{529 \times \cdot 3125}{1/12 \times \cdot 437 \times \overline{\cdot 625}^3 \times 1\cdot 5}$$

$$f_{bu} = \frac{1040}{\cdot 00435 \times 1\cdot 5} + \frac{165}{\cdot 0089 \times 1\cdot 5} = 159{,}386 + 12{,}359 = 171{,}745 \text{ psi (ULT)}$$

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE
HOOK SIDE LOAD LIMITS
SECTION A-A (CONT'D)

$$f_{SU} = \frac{15000 + 1666}{.625 \times .437} = \frac{16666}{.273} = 61047$$

$$f_{SMAX} = \sqrt{(61\times10^3)^2 + \left(\frac{172}{2}\times10^3\right)^2} = 10^3\sqrt{3721+7396} = 10^3\sqrt{11117} = 105,437 \text{ psi}$$

$$f_{NMAX} = \frac{171,745}{2} + 105,437 = 191,309 \text{ psi}$$

$$MS = \frac{180}{191} - 1 = -.058$$

DECREASE DOWN LOAD TO 14000 PER HOOK

$$f_{bu} = \frac{.3175 \times 14000 \times .2185}{.00435 \times 1.5} + 12,359 = \frac{971.23}{.00653} + 12359$$

$$f_{bu} = 148,733 + 12,359 = 161,092$$

$$f_{SU} = \frac{14000 + 1666}{.273} = \frac{15666}{.273} = 57,384$$

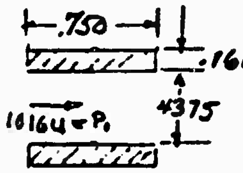
$$f_{SMAX} = \sqrt{(57.4\times10^3)^2 + \left(\frac{161}{2}\times10^3\right)^2} = 10^3\sqrt{3253+6480} = 98,650 \text{ psi}$$

$$f_{NMAX} = \frac{161,092}{2} + 98,650 = 80,546 + 98,650 = 179,200$$

$$MS = \frac{180}{179.2} - 1 = +.004$$

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE
HOOK SIDE LOAD LIMITS REF P-13
SECTION - B-B

PITCHING MOMENT = $.4375 P_1 = .4375 \times .726 R$ (P13 REF)
$= .4375 \times .726 \times 14000 = 4446$



SECTION B-B

$$f_{bu} = \frac{4446 \times .375}{2 \times \frac{1}{12} \times .161 \times .750^3 \times 1.5} = \frac{2223 \times .375}{.00566 \times 1.5} = 98,190$$

$$f_{su} = \frac{10164}{2 \times .161 \times .750} = \frac{10164}{.2415} = 42,086$$

$$f_{s\,max} = 10^3 \sqrt{(42.1)^2 + (49.1)^2} = 10^3 \sqrt{1772 + 2410} = 64,700$$

$$f_{m\,max} = 49,100 + 64,700 = 113,800$$

$$M.S = \frac{180}{114} - 1 = +.578$$

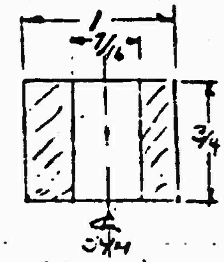
SHARP RADIUS AT THE CORNER OF THIS SECTION WILL PRODUCE STRESS CONCENTRATION BUT INFORMATION AVAILABLE ONLY ROUGHLY APPROXIMATES THE CASE
STRESS CONCENTRATION DESIGN FACTORS - PETERSON
BAR WITH A SHOULDER FILLET IN BENDING FIG 60

$$\frac{r}{d} = \frac{.03}{.161} = .186 \qquad \frac{D}{d} = \frac{.750}{.161} = 4.6 \qquad K_t = 1.55$$

$$f_{m\,max} = 1.55 \times 113,800 = 176,390$$

$$M.S = \frac{180}{176} - 1 = +.02$$

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE
HOOK SIDE LOAD LIMITS REF P13
SECTION D-D



PITCHING MOMENT 14000 × (.633 + .093) = 10,164 IN# (ULT)
TRANSVERSE MOMENT = 1666 (25/32 − 7/32) = 1250 IN# (ULT)
TORQUE = 1666 (.633 + .093) = 1210 IN# ULT
TENSION COMPONENT OF DOWN LOAD = R = 14,000
SHEAR DUE TO SIDE LOAD = R_Y = 1666.

$$f_{bu} = \frac{10{,}164 \times .5}{\frac{1}{12} \times .750 (1^3 - .4375^3) \times 1.5} + \frac{1250 \times .375}{\frac{1}{12} \times .5625 \times .750^3 \times 1.5} + \frac{14000}{.75(.5625)}$$

$$f_{bu} = \frac{10{,}164 \times .5}{.0573 \times 1.5} + \frac{1250 \times .375}{.020 \times 1.5} + \frac{14000}{.422}$$

$$f_{bu} = 59127 + 15625 + 33175 = 107{,}927$$

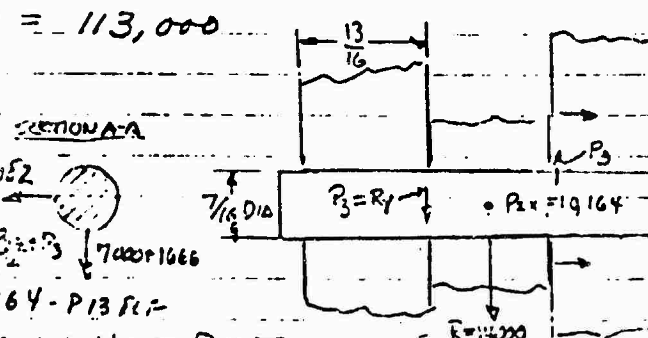
$$f_{su} = \frac{1210}{.208 \times .75 \times .625^2} + \frac{1666}{.75 \times .5625}$$

$$f_{su} = \frac{1210}{.0609} + \frac{1666}{.422} = 19{,}868 + 3948 = 23{,}815$$

$$f_{s\,max} = 10^3 \sqrt{(23.8)^2 + (54)^2} = 10^3 \sqrt{566 + 2916} = 59{,}000 \text{ psi (ULT)}$$

$$f_{m\,max} = 54{,}000 + 59{,}000 = 113{,}000$$

$$M_S = \frac{180}{113} - 1 = +.59$$



PIVOT PIN

$P_{1Z} = R = 14{,}000$ P13 P15 REF
$P_3 = R_Y = 1666^{\#}$ P13 & P15 REF
$P_{2X} = .726 R = .726 \times 14000 = 10164$ - P13 REF
ASSUME PIN IS TIGHT FITTING IN HOOK PIVOT HOLE AND AGAINST BACK FRAME SO THAT NO BENDING EXISTS.

$$f_{su} = \frac{\sqrt{(7000 + 1666)^2 + (5052)^2}}{.1503} = \frac{\sqrt{(8666)^2 + (5052)^2}}{.1503} = \frac{10^3\sqrt{75.1 + 25.5}}{.1503} = \frac{10.050}{.1503}$$

$$f_{su} = 66{,}866 \text{ psi} \qquad M_S = \frac{106}{66.9} - 1 = +.58$$

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE YAWING MOMENT DISTRIBUTION

THIS REPORT HAS DEMONSTRATED THAT THE AERO 7A RACK LOADS SPECIFIED IN THE DOUGLAS STRENGTH ENVELOPE ARE GREATLY IN EXCESS OF THOSE WHICH THE RACK CAN SAFELY SUSTAIN. AS INDICATED ON PAGE 4, DOUGLAS EVIDENTLY ALSO ASSUMED, IN THE DERIVATION OF THE STRENGTH ENVELOPE, THAT THE YAWING MOMENT WAS REACTED BY HOOK SIDE LOAD RATHER THAN BY THE SWAY BRACES. THIS ASSUMPTION WILL BE CHECKED IN THE FOLLOWING ANALYSIS.

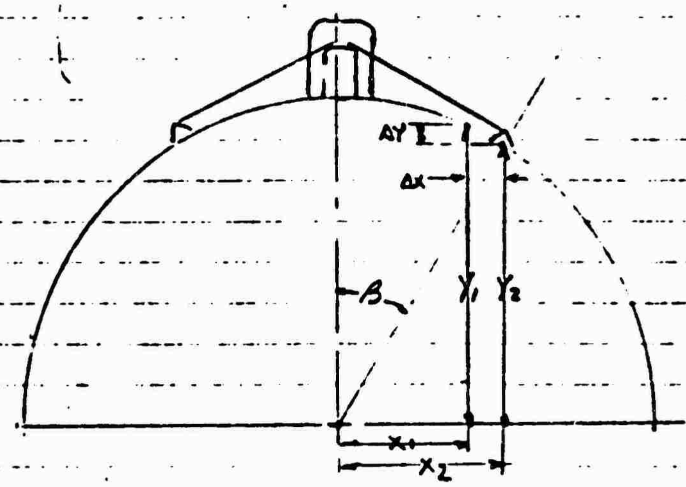
ASSUME THAT THE STORE IS SUBJECTED TO YAWING MOMENT ONLY, AND THAT THE STORE ROTATES IN THE HORIZONTAL PLANE TO ALLOW THE LUGS TO JUST BEGIN TO BEAR AGAINST THE SIDES OF THE HOOKS. FOR THE STORE TO ACHIEVE THIS POSITION THE SWAY BRACES MUST DEFLECT SUFFICIENTLY TO ALLOW THE STORE TO SLIP UNDERNEATH THEM. THE VERTICAL DEFLECTION OF THE BRACES (ΔY) IS DERIVED AS A FUNCTION OF THE DISTANCE THAT THE STORE ROTATES LATERALLY (ΔX) JUST AT HOOK CONTACT. ΔY IS THEN CONVERTED INTO A RESULTANT BRACE DEFLECTION AND COMPARED TO THE DEFLECTION RECORDED DURING TESTING TO OBTAIN THE RESULTANT BRACE LOAD IMPARTING THE TEST DEFLECTION. THIS BRACE LOAD WHICH IS ACTING AT HOOK-LUG CONTACT IS THEN ASSUMED TO BE THE LIMITING BRACE REACTION TO YAWING MOMENT WHILE THE REMAINDER IS REACTED BY HOOK SIDE LOAD.

THE TEST DATA, EXTRACTED FROM NADC REPORT # NADC-AM-6739 (TABLES I & III - BRACE TO GROUND, AFT END) IS ASSUMED TO REPRESENT A LOAD DEFLECTION CURVE FOR THE RACK-BRACE COMBINATION. THE ANALYSIS DOES NOT CONSIDER ROTATION OF THE STORE DUE TO SIDE LOAD.

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE

YAWING MOMENT DISTRIBUTION

DERIVING $\Delta X = f \Delta Y$.



X_2 & Y_2 ARE THE COORDINATES OF THE BRACE RELATIVE TO THE STORE IN ITS ORIGINAL POSITION

X_1 & Y_1 ARE THE COORDINATES OF THE BRACE RELATIVE TO THE STORE AFTER THE STORE SLIPS BENEATH THE BRACES DUE TO YAWING MOMENT

ΔX = DISTANCE STORE MOVES HORIZONTALLY RELATIVE TO THE BRACE

ΔY = DISTANCE BRACE MOVES VERTICALLY

$$X_1^2 + Y_1^2 = R^2$$

$$\Delta Y = Y_1 - Y_2$$

$$\Delta X = X_2 - X_1$$

$$Y_1 = \sqrt{R^2 - X_1^2}$$

$$\Delta Y = Y_1 - Y_2 = \sqrt{R^2 - X_1^2} - Y_2$$

$$X_1 = X_2 - \Delta X$$

$$\Delta Y = \sqrt{R^2 - (X_2 - \Delta X)^2} - Y_2$$

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE
YAWING MOMENT DISTRIBUTION

HORIZONTAL DIMENSION OF LUG HOOK OPENING MIL-A-8591D
FIG 2 & 3 1000 & 2000# WEIGHT CLASSES

T65 30" LUG $1.125 \, {}^{+.030}_{-.000}$ MAX = 1.155 FIG 3
T63 14" LUG $.72 \, {}^{+.030}_{-.000}$ MAX = .75 FIG 2

HOOK WIDTH
T65 30" HOOK = .625
T63 14 HOOK = .500

ΔX = CLEARANCE = LUG DIMENSION - HOOK DIMENSION
T65 30" = 1.155 - .625 = .530
T63 14" = .750 - .500 = .250

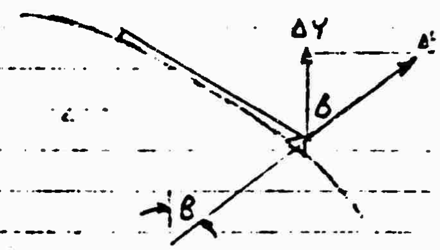
T63 STORE 14" SUSPENSION $B = 17°43'$ $R = 15.25"$
$X_2 = R \sin B = 15.25 \times .30431 = 4.64$ P2-REF
$Y_2 = R \cos B = 15.25 \times .95257 = 14.527$ P2-REF

T65 STORE 30" SUSPENSION $B = 34°25'$ $R = 7.25"$
$X_2 = 7.25 \times .56521 = 4.10$
$Y_2 = 7.25 \times .82495 = 5.98$

T63 STORE
$\Delta Y = \sqrt{R^2 - (X_2 - \Delta X)^2} - Y_2$ P22-REF
$\Delta Y = \sqrt{(15.25)^2 - (4.64 - .250)^2} - 14.527$
$\Delta Y = \sqrt{232.5 - 19.27} - 14.527$
$\Delta Y = \sqrt{213.23} - 14.527 = 14.602 - 14.527 = .0754$

T65 STORE
$\Delta Y = \sqrt{(7.25)^2 - (4.10 - .530)^2} - 5.98$
$\Delta Y = \sqrt{52.563 - 12.745} - 5.98$
$\Delta Y = \sqrt{39.818} - 5.98 = 6.31 - 5.98 = .33$

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE
YAWING MOMENT DISTRIBUTION
CONVERTING THIS DEFLECTION TO A RESULTANT AT $\theta = 45°$ FOR COMPARISON WITH TEST DATA·
RESULTANT DEFLECTION OF BRACE = $\frac{\Delta Y}{\cos\theta}$



T63 STORE $\Delta B = \frac{.0754}{66913} = .112$

T65 STORE $\Delta B = \frac{.33}{.66913} = .493$

COMPARING THESE VALUES OF RESULTANT BRACE DEFLECTION WITH THOSE DERIVED ON P 12a (NADC REPORT # NADC-AM-6739 - TABLES I & III - REF) IDENTIFIES A SWAY BRACE LOAD· THIS IS THE LOAD REQUIRED TO DEFLECT THE BRACE STRUCTURE ALONE TO A DISTANCE ΔY WHICH IS LARGE ENOUGH TO ALLOW THE STORE TO SHIFT LATERALLY AND MAKE HOOK- LUG CONTACT- AFTER THIS OCCURS THE BRACES ARE NO LONGER EFFECTIVE IN RESISTING YAWING MOMENT AND ALL OF THE YAWING MOMENT COMES OUT AS SIDE LOAD ON THE HOOKS· THE LOAD DEFLECTION CURVES IN TABLE I & III UNDER BRACE TO FRAME (FWD END) ARE USED AS A DEFINITION OF BRACE DEFLECTION:

THE YAWING MOMENT CAPACITY OF THE BRACES IS DICTATED BY THE REQUIREMENT FOR THE BRACES TO CLIMB AN INCLINE PRESENTED BY THE STORE AS IT ROTATES IN THE HORIZONTAL PLANE. REGARDLESS OF WHAT OTHER LOADS ARE APPLIED TO THE BRACES, THIS SAME REQUIREMENT IS PRESENTED TO THE BRACE AS ANY ATTEMPT IS MADE TO YAW THE STORE. FOR INSTANCE, IF THE BRACE IS LOADED BY STORE SIDE LOAD IT WILL DEFLECT BUT WHEN AN ATTEMPT IS THEN MADE TO YAW THE STORE IT MUST DEFLECT THE BRACES BY THE ADDITIONAL INCREMENT REQUIRED TO CLIMB THE STORE INCLINE- DOWN LOAD WOULD TEND TO RELIEVE THIS SITUATION, BUT IN THIS CASE THE RELIEF IS OFFERED BY THE DEFLECTION OF THE HOOKS WHICH ALLOWS THE STORE SURFACE TO MOVE AWAY FROM THE BRACES· HOWEVER, SINCE THE HOOKS ARE MORE RIGID THAN THE BRACES, THIS AFFECT IS NOT AS SIGNIFICANT AS BRACE DEFLECTION· PITCHING MOMENT CAN ALSO RELIEVE A BRACE AND FACILITATE SLIPPAGE UNDER YAW BUT THIS ALSO DEMANDS DEFLECTION OF CLE,

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE
YAWING MOMENT DISTRIBUTION

OF THE MORE RIGID HOOKS. THE BOMB RACK STRUCTURE IS SUCH THAT YAWING MOMENT MOST EFFECTIVELY SURS THE STORE UNDER THE BRACES. IF THE BRACE LOAD SUPPLIED BY YAWING MOMENT IS ONLY HIGH ENOUGH ON ONE BRACE TO ALLOW SLIPPAGE TO THE POINT WHERE THE HOOK WILL FEEL SIDE LOAD, THEN THE STORE WILL TEND TO PIVOT ABOUT THE BRACE WITH THE LEAST LOAD.

REFERRING TO PAGE 12a

T63 STORE 30.5" DIA 14" SUSPENSION

THE NATC FIX DATA (TABLE III) IS USED FOR COMPARATIVE PURPOSES

AT .112 DEFLECTION

$$\frac{.112-.084}{.119-.084}(4584-3438) = \frac{.028}{.035} \times 1146 = 917 \quad R_{.112} = 3438+917 = 4355$$

$$\bar{R}_{D'4\alpha'} = \frac{R_1 \times a_1 \sin\beta_1}{a_2 \sin\beta_2} = \frac{4355 \times 6.312 \times .74314}{10.375 \times .30431} = 4099 \quad \begin{cases} P25a\ (REF) \\ P12\ REF \\ P2\ REF \end{cases}$$

T65 STORE 14.5" DIA 30" SUSPENSION

THE UNMODIFIED RACK DATA (TABLE I) IS USED FOR COMPARATIVE PURPOSES

AT .493 DEFLECTION

THIS DEFLECTION IS BEYOND THE FAILURE LIMIT OF THE BRACE

THE SIGNIFICANCE OF THIS RESULT IS THAT ON THE T63 STORE (LARGE DIAMETER) THE BRACES WILL REACT A YAWING MOMENT $= 20 \times 4099 \sin\beta = 20 \times 4099 \times .30431 = 24947$ IN# BEFORE THE STORE LUGS CONTACT THE SIDES OF THE HOOKS. ON THE T65 STORE (SMALL DIAMETER) THE BRACES WILL REACT YAWING MOMENT UNTIL A BRACE FAILURE OCCURS.

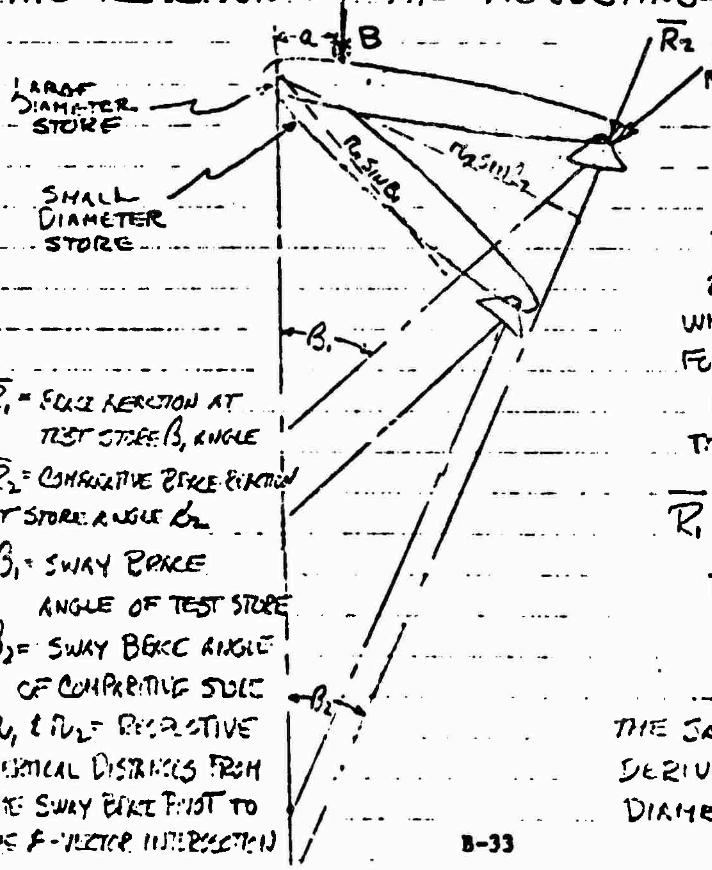
THIS CONCLUSION CONCURS WITH PREVIOUS EXPERIENCE AND WORK DONE ON OTHER RACKS IN WHICH LARGE DIAMETER STORES WERE PRONE TO SLIPPAGE UNDER YAWING MOMENT WHILE SMALL DIAMETER STORES WERE NOT. THIS IS ALSO APPARENT FROM THE BASIC BRACE GEOMETRY.

REACTION OF YAWING MOMENT ON THE BRACES SHOULD ALLOW AN ADJUSTMENT ON THE HOOK DOWNLOAD (P17 CRITICAL SECTION) SINCE IT WAS ASSUMED THAT ALL OF THE YAWING MOMENT WAS REACTED BY SIDE LOAD ON THE HOOKS. CHANGE NOTED IN CONCLUSIONS P26.

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE

YAWING MOMENT DISTRIBUTION

A CORRECTION HAS TO BE MADE TO THE DATA EXTRACTED FROM NADC REPORT NADC-AM-6739 BECAUSE THE TESTS SPECIFIED WERE MADE ON A STORE HAVING A β ANGLE OF 45°. THE RESULTANT FORCE ACTING ON THE SWAY BRACE ADJUSTING BOLT, WHICH DETERMINES THE FAILURE POINT OF THE RACK, IS SIGNIFICANTLY INFLUENCED BY BOTH THE DIRECTION OF THE FORCE VECTOR ACTING ON THE SWAY BRACE AND THE STORE DIAMETER. THE INFLUENCE OF THE STORE DIAMETER CAUSES THE ADJUSTING BOLT TO FAIL AS A COLUMN WHEN IT IS ADJUSTED TO CONTACT A SMALL DIAMETER STORE OR FOR THE RACK FRAME TO FAIL IN SHEAR WHEN THE BOLT IS RETRACTED TO ACCOMMODATE A LARGE DIAMETER STORE. HOWEVER THE DATA ALSO HAS TO BE CORRECTED TO COMPENSATE FOR THE ANGLE AT WHICH THE FORCE VECTOR ACTS ON THE BRACE PAD. THIS ANGLE CHANGES THE MAGNITUDE OF THE REACTION AT THE ADJUSTING BOLT.



$\overline{R}_1$ = FORCE REACTION AT TEST STORE β_1 ANGLE

$\overline{R}_2$ = COMPARATIVE BRACE REACTION AT STORE ANGLE β_2

β_1 = SWAY BRACE ANGLE OF TEST STORE

β_2 = SWAY BRACE ANGLE OF COMPARATIVE STORE

r_1 & r_2 = RESPECTIVE VERTICAL DISTANCES FROM THE SWAY BRACE PIVOT TO THE F-VECTOR INTERSECTION

$$\Sigma M_{BRACE\ PIVOT} = \overline{R}_1 r_1 \sin\beta_1 = a \cdot B$$

$$\Sigma M_{BRACE\ PIVOT} = R_2 r_2 \sin\beta_2 = a \cdot B$$

WHERE B = BRACE FAILURE LOAD FOR THE LARGE DIAMETER STORE

a = HORIZONTAL DISTANCE TO THE ADJUSTING BOLT FORCE

$$\overline{R}_1 r_1 \sin\beta_1 = \overline{R}_2 r_2 \sin\beta_2$$

$$\overline{R}_2 = \frac{\overline{R}_1 r_1 \sin\beta_1}{r_2 \sin\beta_2}$$

THE SAME EQUATION CAN BE DERIVED FOR THE SMALL DIAMETER STORE

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE
YAWING MOMENT DISTRIBUTION

THE LIMITING YAWING MOMENT DERIVED FOR THE LARGE DIAMETER WAS BASED ON A 14" SUSPENSION USING THE SMALLER LUG SPECIFIED IN MIL-A-8591D. CONSIDERING THE LARGE DIAMETER STORE WITH A 30" LUG RESULTS IN THE FOLLOWING LIMITATION.

T63 STORE 30.5 DIA 30" SUSPENSION:

$\Delta X = 1.155 - .625 = .530$ P23 (REF)

$\Delta Y = \sqrt{R^2 - (X_2 - \Delta X)^2} - Y_2$ P22 (REF.)

$\Delta Y = \sqrt{15.25^2 - (4.64 - .530)^2} - 14.527$ P23 (REF)

$\Delta Y = \sqrt{232.5 - 16.89} - 14.527 = \sqrt{215.61} - 14.527$

$\Delta Y = 14.683 - 14.527 = .1566$

$\Delta B = \dfrac{.1566}{.66913} = .234$

REFERRING TO THE NATC FIX DATA (TABLE III) FOR COMPARATIVE PURPOSES (P12a - REF)

$\dfrac{.234 - .217}{.258 - .217}(9168 - 8022) = \dfrac{.017}{.041} \times 1146 = 475$ $\bar{R}_{45} = 8022 + 475 = 8497$

$\bar{R}_{17°43'} = \dfrac{8497 \times 6.312 \times .74314}{16.375 \times .30431} = 7998$ P25a (REF)

LIMITING YAWING MOMENT = $20 \times 7988 \times \sin\beta = 159{,}760 \times .30431 = 48{,}616$ IN#

CONCLUSIONS

30" SUSPENSION

LARGE DIAMETER STORE (T63)

LIMITING BRACE YAWING MOMENT = 48,616 IN# (ULT)

YAWING MOMENT REACTABLE BY HOOK SIDE LOAD = 51,384 (ULT)

HOOK DOWN LOAD = 14000 # (ULT) PER SINGLE HOOK } WHEN YAWING MOMENT > 48616
= 28000 " (ULT) PER HOOK STATION }

DECREASE IN SIDE LOAD SHOULD ALLOWS APPROX 1000# INCREASE IN DOWN LOAD (NOT CALCULATED)

BRACE LOAD ($\bar{R}$ MAX.) = $\dfrac{15,000 \times 6.312 \times .74314}{16.375 \times .30431} = 15{,}532$ P12 & 25a (REF)

CONCLUSIONS FROM DOUGLAS STRENGTH ENVELOPE

CONCLUSIONS

30" SUSPENSION

SMALL DIAMETER STORE

LIMITING BRACE YAWING MOMENT = BRACES REACT ALL YAWING MOMENT TO FAILURE WITHOUT HOOK CONTACT

HOOK DOWN LOAD = 18,500# PER SINGLE HOOK P11 (REF)
37,000# PER HOOK STATION

BRACE LOAD ($\bar{R}$MAX) = $\frac{9000 \times 6.562 \times .74314}{8.81 \times .56521}$ = 8813# (P12 & 25a REF)

14" SUSPENSION

LARGE DIA STORE

LIMITING BRACE YAWING MOMENT = 24,947# (ULT)

YAWING MOMENT REACTIBLE BY HOOKS - NOT ANALYZED

HOOK DOWN LOAD - NOT ANALYZED

BRACE LOAD ($\bar{R}$ MAX) = 15,532# (ULT)

SMALL DIA STORE

NOT ANALYZED

RHU-8 TOW REEL

THE PURPOSE OF THIS ANALYSIS IS TO DEFINE THE STRENGTH LIMITS OF THE AERO 7A EJECTOR BOMB RACK WHEN SUPPORTING AN RHU-8 TOW REEL. THE PRECEDING ANALYSIS HAS BEEN CONFINED TO THE T63 AND T65 STORES AS A MEANS OF EVALUATING THE DOUGLAS STRENGTH ENVELOPE AND DEVELOPING A METHOD FOR ANALYZING RACK STRENGTH AS A FUNCTION OF STORE DIAMETER. THE FOLLOWING ANALYSIS APPLIES THAT METHOD TO THE RHU-8 TOW REEL.

RHU-8 TOW REEL CHARACTERISTICS

12.3" RADIUS — $\beta = 21.5°$ $\sin\beta = .36650$ $\cos\beta = .93042$

$e = 1.6$ — NO ECCENTRICITY

$\mu = 1.2$

FWD LUG 65.8" FROM NOSE OF TOW REEL (STA 0)

AFT LUG 95.8 " " " " "

CG (EMPTY = 866#) = 58.8 " " " " "

CG (LOADED = 1569#) = 65.3 FROM NOSE OF TOW REEL (STA 0)

YAWING MOMENT DISTRIBUTION

30" SUSPENSION

$\Delta x = 1.155 - .625 = .530$ P 23 (REF)

$x_2 = R\sin\beta = 12.3 \times .36650 = 4.508$

$Y_2 = R\cos\beta = 12.3 \times .93042 = 11.444$

$\Delta Y = \sqrt{R^2 - (x_2 - \Delta x)^2} - Y_2$ P 22 (REF)

$\Delta Y = \sqrt{(12.3)^2 - (4.508 - .530)^2} - 11.444$

$\Delta Y = \sqrt{151.29 - 15.82} - 11.444 = \sqrt{135.47} - 11.444 = 11.64 - 11.44 = .20$

$\Delta B = \frac{.200}{\cos\beta} = \frac{.200}{.66913} = .298$

REFERRING TO THE NATC FIX DATA (TABLE III) FOR COMPARATIVE PURPOSES. P-12a (REF)

$\frac{.298 - .258}{.356 - .258}(10{,}314 - 9168) = \frac{.040}{.098} \times 1146 = 467$

$\bar{R}_{as}$ PER SPACE $= 9168 + 467 = 9635$

$\bar{R}_{2} = \frac{\bar{R}_1 M_R \cos\beta_1}{M_2 \sin\beta_2} = \frac{9635 \times 6.312 \times .74314}{13.9 \times .36650} = 8870$ P. 25a (REF)

BRU-5 TOW PEEL

LIMITING YAWING MOMENT = 8870 × 20 × .36650 = 65,017

YAWING MOMENT REACTED BY HOOK SIDE LOAD = 100,000 − 65017 = 34,983

SIDE LOAD PER HOOK STATION = 34983 / 30 = 1166

SIDE LOAD PER SINGLE HOOK = 1166/2 = 583

HOOK STRENGTH − CRITICAL SECTION P17 & 18 (REF)

INCREASE DOWN LOAD TO 15,000# SIDE LOAD = 583

$$f_{bu} = \frac{.3175 \times 15000 \times .2185}{.00435 \times 1.5} + \frac{.3175 \times 583 \times .3125}{.0089 \times 1.5}$$

$$f_{bu} = 159,387 + 4333 = 163,720$$

$$f_{su} = \frac{15000 + 583}{.273} = 57,080$$

$$f_{s\,MAX} = 10^3 \sqrt{(58)^2 + (82.0)^2} = 10^3\sqrt{3364 + 6724} = 10^3\sqrt{10088} = 100,500$$

$$f_{N\,MAX} = \frac{163,720}{2} + 100,500 = 182,360 \text{ psi}$$

$$MS = \frac{180}{182} - 1 = -.011$$

USE DOWN LOAD = 14,500# OR 29,000# PER HOOK STATION.

IF THE APPLIED YAWING MOMENT IS LESS THAN THE SPACE CAPACITY THEN THE HOOKS WILL NOT BE SUBJECTED TO SIDE LOAD AND DOWN LOAD CAN BE INCREASED TO THE VALUE SPECIFIED ON PAGE 11

DOWN LOAD PER SINGLE HOOK = 18,500# (ULT)

DOWN LOAD PER HOOK STATION = 37,000# (ULT)

DRAG LOAD IN ALL CASES IS ASSUMED TO BE REACTED BY BEARING OF THE LUG SURFACE AGAINST THE BOMB RACK FRAME AND IS NOT CONSIDERED CRITICAL ON THE RACK WITHIN THE LIMITS OF MIL-A-8591.

RHU 5 TOW REEL

BRACE LIMITING STRENGTH

$$\bar{R}_2 = \frac{\bar{R}_1 n_1 \sin\beta_1}{n_2 \sin\beta_2} \quad P25a\ (REF)$$

$$\bar{R}_2 = \frac{16{,}500 \times 6.312 \times .74314}{13.9 \times .36650} = 15{,}192$$

CONCLUSION RHU-5 STORE (7A RACK STRENGTH LIMITS)

1- LIMITING BRACE YAWING MOMENT = 65,017 IN-# (P29-REF) ABOVE THIS VALUE THE HOOKS REACT YAWING MOMENT AS SIDE LOAD

2- HOOK DOWN LOAD

(a) YAWING MOMENT > 65,017 IN-# < 100,000 IN#
HOOK DOWN LOAD PER STATION = 29,000 (ULT) (P29-REF)

(b) YAWING MOMENT ≤ 65017 IN.#
HOOK DOWN LOAD PER STATION = 37,000# (P29-REF)

3- BRACE LOAD ($\bar{R}$) = 15,192 (ULT) (P-30-REF)

4- DRAG NOT CRITICAL (P29-REF)

RECOMMENDATIONS. IT IS RECOMMENDED THAT THE FOLLOWING INSPECTION OF THE AERO 7A RACK BE MADE BEFORE AND AFTER EACH FLIGHT

1- TIGHTEN THE SWAY BRACE ADJUSTING BOLTS IN ACCORDANCE WITH THE PROCEDURE SPECIFIED IN THE NATOPS MANUAL

2- INSPECT THE SWAY BRACE ADJUSTING BOLTS FOR BRINELLING AT THE POINT WHERE IT CONTACTS THE BRACE

3- CHECK TO SEE THAT THE SWAY BRACE ADJUSTING BOLT CAN BE ROTATED IN ITS MATING THREAD

4- CHECK FOR BULGES OR CRACKS AT THE OUTBOARD AND UPPER PORTIONS OF THE FRAME IN THE AREAS OF THE ADJUSTING BOLT INSTALLATIONS

5- IF THE ADJUSTING BOLT IS BENT OR THE FRAME BULGED OR CRACKED, THE RACK SHOULD BE REPLACED.

(31)

REFERENCES 7 MAY 1974

MR JESS LOCKHART McCONNELL DOUGLAS AIRCRAFT CO
LONG BEACH CAL PHONE 1-213-593-4759

CALLED MR LOCKHART TO INQUIRE ABOUT THE AERO 7A EJECTOR BOMB RACK STRENGTH ENVELOPE. HE READ ME INFORMATION FROM A PUBLICATION ENTITLED "STANDARD AIRCRAFT ARMAMENT CHARACTERISTICS (BOMB RACK - 4 HOOK - AERO 7A - 3600 LB) DATED NOV 1950: THIS DATA EXACTLY CONCURRED WITH THE CURVES PUBLISHED IN AN IDENTICAL PUBLICATION AVAILABLE AT NADC BUT DATED 1 JULY 1955.

REFERENCES

- A4/TA-4 TACTICAL MANUAL (CONF) NAVAIR-01-40AV-1T
- NATOPS FLIGHT MANUAL (A4M) NAVAIR-01-40AVM-1
- AIRBORNE WEAPONS/STORES LOADING MANUAL NAVAIR 01-40AV-75
- AIRCRAFT, BOMBS, FUZES AND ASSOCIATED COMPONENTS NAVWEPS OP2216
- DOUGLAS AIRCRAFT CO STANDARD AIRCRAFT ARMAMENT CHARACTERISTICS BOMB EJECTOR RACK - 4 HOOK - AERO 7A - 3600 LB
- NADC REPORT NADC-AM-6739 OF 20 NOV 1967 - "UPGRADING OF THE AERO 7A EJECTOR BOMB RACK FOR THE A6A AIRCRAFT
- NADC REPORT NADC 72136-VT OF 31 DEC, 1972 - "DETERMINATION OF THE LUG AND SWAY BRACE REACTIONS FOR THE MAU-9/A BOMB RACK"
- MIL-A-8591 - "AIRBORNE STORES AND ASSOCIATED EQUIPMENT; GENERAL DESIGN CRITERIA FOR"
- MIL-R-22622 (WEP) "RACK, BOMB EJECTOR AIRCRAFT; AERO 7A SERIES
- MIL-T-7743 "TESTING, STORE SUSPENSION EQUIPMENT, GENERAL SPEC FOR"
- DAYTON T. BROWN INC CHURCH STREET, BOHEMIA N.Y. TEST REPORT DTB02R73-1517 - "MODIFIED AERO 7A-1 BOMB EJECTOR RACK INVESTIGATION"
- NARF (NORFOLK VA) REPORT SERIAL NO 99-72 of 7 APRIL 72

RELATED AERO 7A RACK IN-SERVICE FAILURES

A NUMBER OF UNSATISFACTORY REPORTS HAVE BEEN FILED CONCERNING FAILURES OF THE AERO 7A RACK IN SERVICE. THE FOLLOWING DESCRIPTION OF A TYPICAL UR WAS TAKEN FROM NARF (NORFOLK VA) REPORT SERIAL NO 99-72 OF 7 APRIL 72.

"DURING AN ABRUPT FULL DEFLECTION RIGHT AILERON ROLL OF THE F8 AIRCRAFT AT 390 KIAS AND 15,000 FT MSL, BOTH THE PORT AND STARBOARD MERS WITH 4 INERT MK20 (ROCKEYE II) STORES ON EACH MER SEPARATED FROM THE WING PYLONS (AERO 7A RACKS) WITH THE STARBOARD MER AND ORDNANCE STRIKING THE AIRCRAFT. THERE WAS NO INDICATION OF IMPENDING FAILURE DURING THE PREVIOUS ROLLS UTILIZING LESS THAN FULL DEFLECTION INPUTS."

"THE DAMAGE TO THE SWAY BRACE ADJUSTING SCREW P/N 66A52850 OR 2444722, AND THE SWAY BRACE ADJUSTING SCREW BOSS (FRAME) IS VERY SIMILAR TO DAMAGE IN PREVIOUS INCIDENTS WHICH WERE INVESTIGATED AT THIS FACILITY. FINDINGS OF PREVIOUS INVESTIGATIONS HAVE BEEN THAT THE AERO 7A WAS SUPPORTING AN ASYMMETRICALLY LOADED MER OR TER (THAT IS THE MER OR TER WAS LOADED HEAVIER ON ONE SIDE THAN ON THE OTHER) WHICH CAUSED A GRAVITATIONAL TORQUE TO BE TRANSFERRED FROM THE MER OR TER TO THE AERO 7A, THROUGH THE HOOKS AND BRACES. CONCLUSIONS WERE THAT THIS TORQUE WHEN MAGNIFIED BY THE AIRCRAFT PULLING SEVERAL g'S WAS GREAT ENOUGH TO CAUSE COMPRESSIVE YIELD OF THE RACK HOUSING IN THE SWAY BRACE SCREW AREA; OR IN THE SWAY BRACE SCREW ITSELF."

THE CONCLUSIONS OF THE NARF REPORT WERE THAT THE FAILURE WAS INITIATED BECAUSE THE AAC520 SPACERS RECOMMENDED IN NADC REPORT NADC-AM-6739 WERE NOT INSTALLED REQUIRING EXTENSION OF THE SWAY BRACE ADJUSTING SCREWS TO CONTACT THE MER AS A SMALL DIAMETER STORE. AS INDICATED IN THIS ANALYSIS THIS CONDITION SIGNIFICANTLY DECREASES RACK STRENGTH. THE ASYMMETRICAL LOADING (SIDE LOAD, ROLLING MOMENT, OFFSET DOWN LOAD) TO WHICH THE BRACES ARE MOST SENSITIVE COMPOUNDED THE SITUATION UNDER ABRUPT AIRCRAFT MANEUVERS.

COMPARATIVE STORES

THE FOLLOWING STORES WITH THE ASSOCIATED AIRCRAFT PERFORMANCE LIMITATIONS SPECIFIED IN THE A4 TACTICAL MANUAL (NAVAIR-01-40AV-1T OF 1 AUG 1970) (CONFIDENTIAL) ARE LISTED HERE FOR COMPARISON WITH THE RMU 8 TOW REEL DIAMETER AND WEIGHT AS A FURTHER MEANS OF ASSESSING AIRCRAFT CAPABILITY. THE AIRCRAFT LIMITATIONS, WHICH ARE CLASSIFIED AS CONFIDENTIAL, ARE NOT SPECIFIED SO THAT THIS REPORT CAN REMAIN UNCLASSIFIED

STORE	WEIGHT LBS	DIAMETER INCHES	RACK	AIRCRAFT STATION	TACTICAL MANUAL LIMITATION (REF)
RMU-8 TOW REEL	1569 (LOADED)	24.6" (EQUIVALENT)	7A	CENTER LINE	—
MK 84	2020	18	7A	" "	PAGE 1-98
MK 40	1057	22.8	7A	" "	" 1-106
MK4 GUN POD	1400	22.5	7A	" "	" 1-118
TER WITH 3 M117 DEMOLITION	2469		7A	CENTER LINE	PAGE 1-100

CHECKING NADC-AM-6739 DATA

THE β ANGLES MEASURED ON THE MER DURING THE TESTS CONDUCTED ON THE UNMODIFIED RACK AND THOSE CONDUCTED ON THE NATC FIX SHOULD HAVE VARIED SLIGHTLY. HOWEVER DUE TO THE DIFFICULTY IN PHYSICALLY MEASURING THIS ANGLE ON THE MER, THE DIFFERENCE IN β, AFTER INSERTING A 1.375 INCH SPACER FOR THE NATC FIX SET-UP, WAS NOT DETECTABLE. CONSEQUENTLY, THE β ANGLE IN BOTH CASES WAS RECORDED AS 45°. THE FOLLOWING ANALYSIS IS INTENDED TO CHECK THIS RESULT AND TO MEASURE ITS INFLUENCE ON THE CALCULATED RACK STRENGTH:

$a^2 = b^2 + c^2 - 2bc \cos\beta$

$\overline{4.985}^2 = b^2 + \overline{6.562}^2 - 2 \times 6.562 \times b \times .66913$

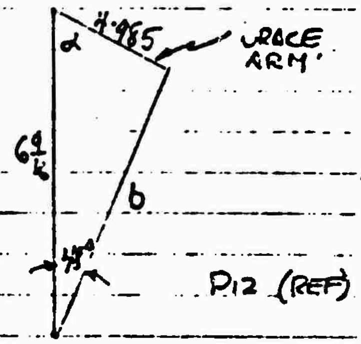
$24.850 = b^2 + 43.05 - 8.78b$

$b^2 - 8.78b + 18.2 = 0$

$b = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$b = \dfrac{8.78 \pm \sqrt{77.09 - 72.8}}{2} = \dfrac{8.78 \pm \sqrt{4.29}}{2}$

$b = \dfrac{8.78 \mp 2.07}{2} = 5.425$ or $\cancel{3.355}$



UNMODIFIED RACK
MER BRACE GEOMETRY

$\sin\alpha = \dfrac{b \sin\beta}{4.985} = \dfrac{5.425 \times .74314}{4.985} = .80873 \quad \alpha = 53°59'$

ADDING A 1.375" SPACER TO THE b DIMENSION

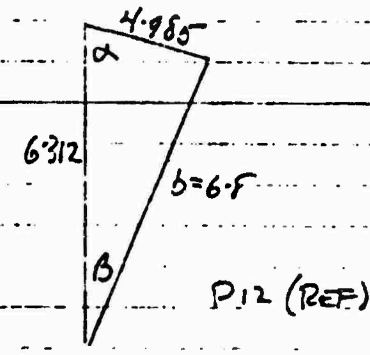
$b_1 = 5.425 + 1.375 = 6.8$

$\overline{4.985}^2 = \overline{6.8}^2 + \overline{6.312}^2 - 2 \times 6.8 \times 6.312 \cos\beta$

$24.850 = 46.24 + 39.841 - 85.843 \cos\beta$

$-61.231 = -85.843 \cos\beta$

$\cos\beta = .71329 \qquad \beta = 44°.30'$



$\sin\alpha = \dfrac{6.8 \times .70091}{4.985} = .95611 \quad \alpha = 72°58'$

NATC FIX
MER BRACE GEOMETRY

CHECKING NADC-AM-6739 DATA

INFLUENCE OF β CHANGE ON RACK STRENGTH

$$\Delta\beta = \frac{.200}{\cos\beta} = \frac{.200}{.71329} = .281 \qquad \text{P28 (REF)}$$

REFERRING TO THE NATC FIX DATA (TABLE III) FOR COMPARATIVE PURPOSES P-129 (REF)

$$\frac{.281-.258}{.356-.258}(10,314-9168) = \frac{.023}{.098} \times 1146 = 269$$

$\overline{R}_{44°36'}$ = PER BRACE = 9168 + 269 = 9436#

$$\overline{R}_{21.5°} = \frac{\overline{R}_1 \, r_1 \sin\beta_1}{r_2 \sin\beta_2} = \frac{9436 \times 6.312 \times .70291}{13.9 \times .36650} = 8195\text{\#} \qquad \text{P252 (REF)}$$

LIMITING YAWING MOMENT = 8195 × 20 × .36650 = 60070

BRACE LIMITING STRENGTH

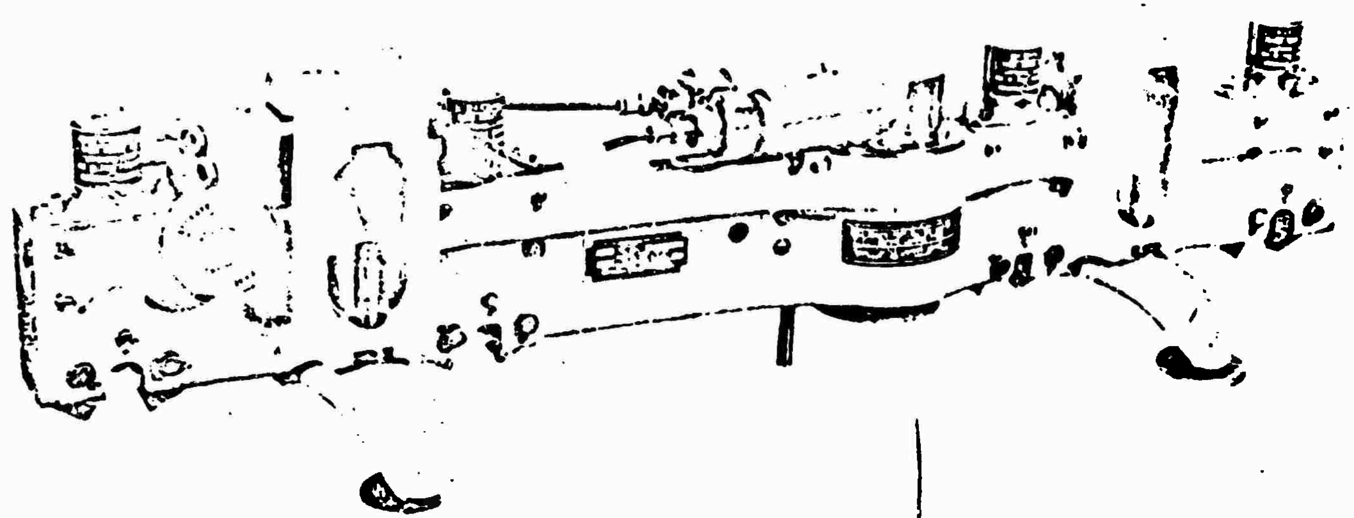
$$\overline{R}_2 = \frac{16,500 \times 6.312 \times .70091}{13.9 \times .36650} = 14,330$$

PERCENTAGE CHANGE

$$\text{LIMITING YAWING MOMENT} = \frac{65017-60070}{65017} = 7.6\,\% \qquad \text{P29 (REF)}$$

$$\text{LIMITING BRACE STRENGTH} = \frac{15,192-14332}{15,192} = 5.6\,\% \qquad \text{P30 (REF)}$$

SINCE THESE CHANGES ARE WITHIN THE EXPECTED ACCURACY OF THE TEST DATA, NO CHANGES WILL BE MADE TO THE CONCLUSIONS GIVEN ON P 30

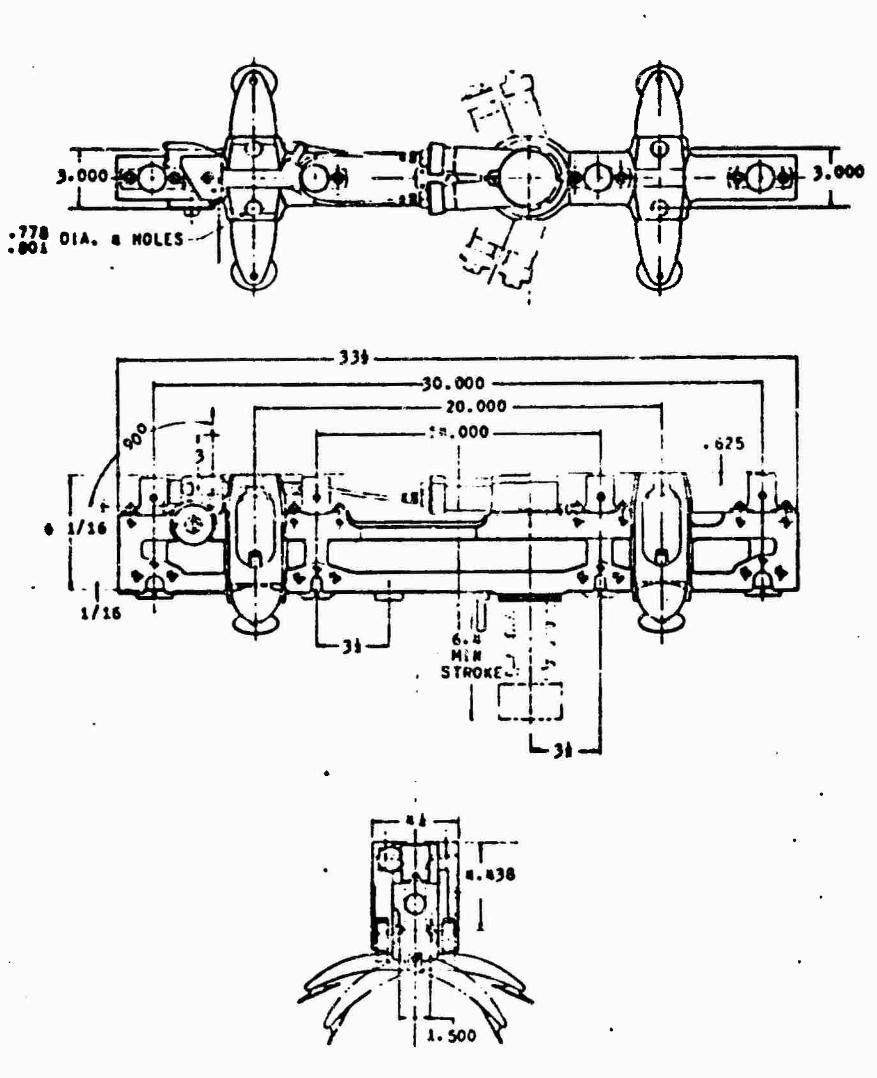
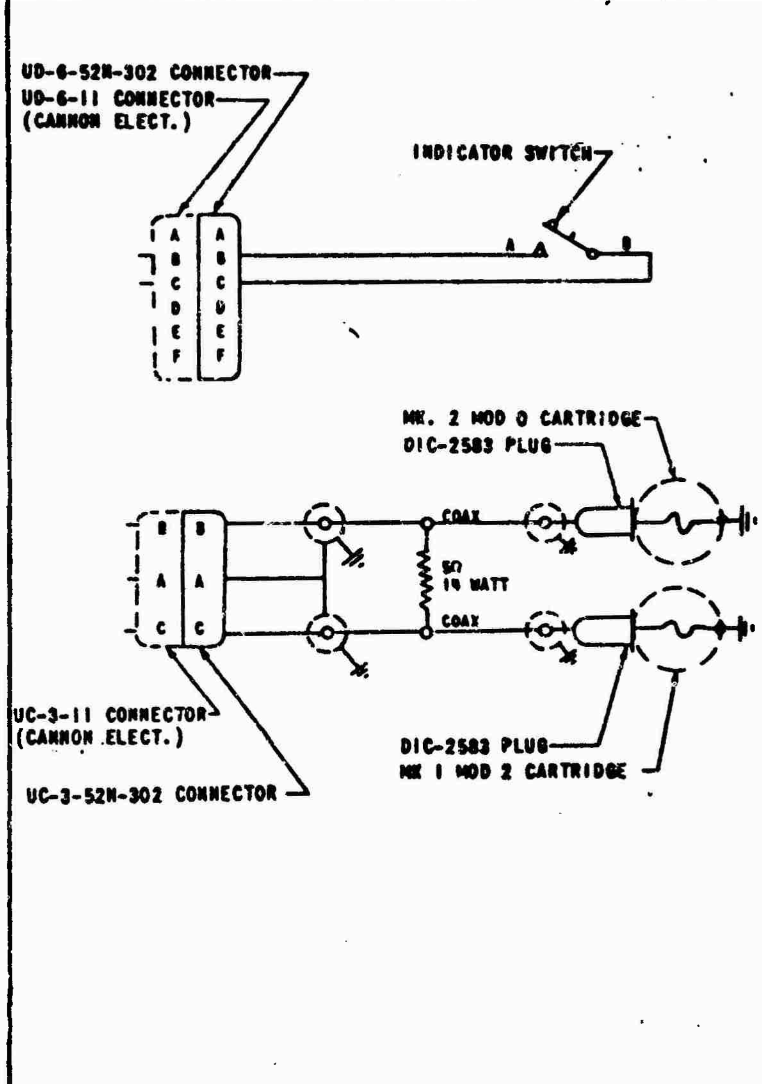


5C170020

STANDARD AIRCRAFT ARMAMENT CHARACTERISTICS

BOMB EJECTOR RACK - 4-HOOK - AERO 7A -3600 LB.

DOUGLAS AIRCRAFT COMPANY, INC., EL SEGUNDO DIVISION

GENERAL ARRANGEMENT	WIRING DIAGRAM
	

1 JULY 1955

AERO 7A EJECTOR RACK

DESCRIPTION

The Douglas Aero 7A 4-hook ejector rack combines in a single lightweight unit, a 14-inch 2-hook rack, a 30-inch 2-hook rack and an ejector. Low-drag sway braces are incorporated in the rack.

The ejector (telescoping piston type) is mounted 3½ inches off center aft for maximum tail-down moment. One Mk.1 Mod.2 cartridge and one Mk.2 Mod.0 cartridge, each with a separate firing circuit, are normally used, although two Mk.2 Mod.0 cartridges may be used for reduced force. The Mk.2 Mod.0 circuit is used for emergency jettison. Both cartridges are ignited by either circuit. A manual release is provided for ground operation or as required by specifications.

The individually self-latching hooks simplify the loading of stores. A removable adapter is available for double-hoisting of stores.

The four-bolt attachment makes the rack easily removable and interchangeable with either the Aero 61B 3-hook rack or the Aero 8A 3-hook ejector rack.

The Aero 7A rack has completed a 250-shot life test and has passed static tests to the design loads. Functional and environmental tests are underway at the contractor's plant. Complete evaluation tests are being conducted at NADC Johnsville.

This rack is also available in a 2-hook, 30-inch configuration (14-inch hooks and sway braces eliminated) for aircraft incorporating integral sway braces.

DEVELOPMENT

Designed and developed for the A4D-1 airplane under Contracts NOa(s) 52-1011C, NOa(s) 53-381, NOa(s) 53-382, and NOa(s) 54-316.

25 experimental 4-hook ejectors have been built and distributed to different manufacturers.

The rack is now in production for several different operational Naval and Air Force models with total quantities exceeding 2000.

ACCOMMODATIONS

G. P. Bombs
100# thru 2000#

Mark 80 Series Bombs - (streamlined)
250# thru 2000#

Practice Stores
T63 T64 T65 T66

Rocket Launchers
All launchers that can be carried on standard Navy 14- and 30-inch suspension systems with lugs in accordance with MIL-A-8591A (AER).

Torpedoes
Mk.13, Mk.34, Mk.41

Mines
Mk.25, Mk.10 - 9, Mk.36, XA-4A, XO-3A, Mk.50

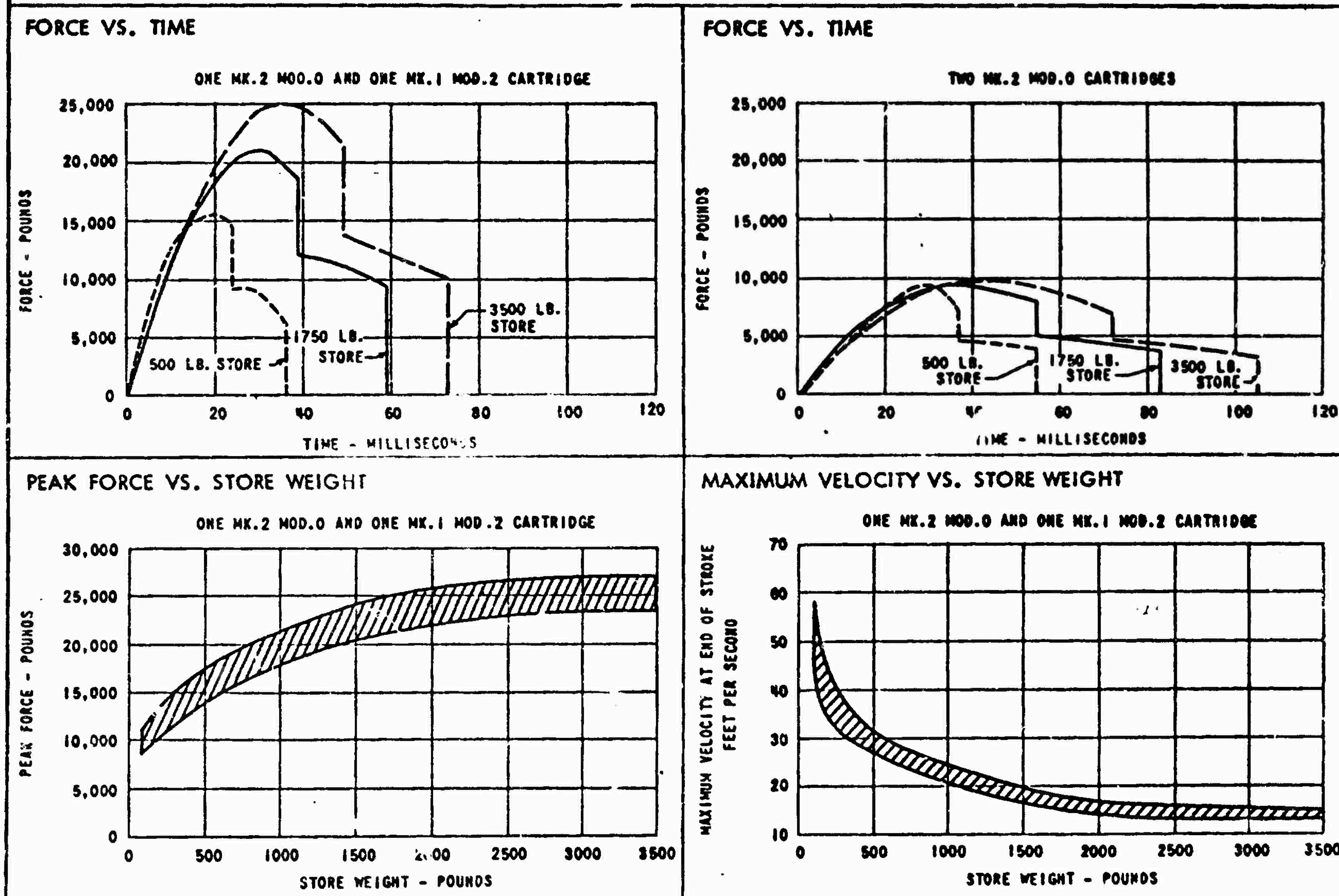
Special Equipment
150 Gal. Fuel Tank
300 Gal. Fuel Tank
Spray Tanks
Practice Bomb Containers
Fragmentation Bombs
Incendiary Bombs
Depth Bombs
Chemical Bombs

WEIGHTS

Weights for a typical installation are as follows:

	4-HOOK	2-HOOK
BASIC RACK	49.0	37.0
FAIRING	12.5	12.5
ATTACHMENT PARTS	1.3	1.3
TOTAL INSTALLED WEIGHT	62.8 lbs.	50.8 lbs.

EJECTOR CHARACTERISTICS



EJECTOR CHARACTERISTICS

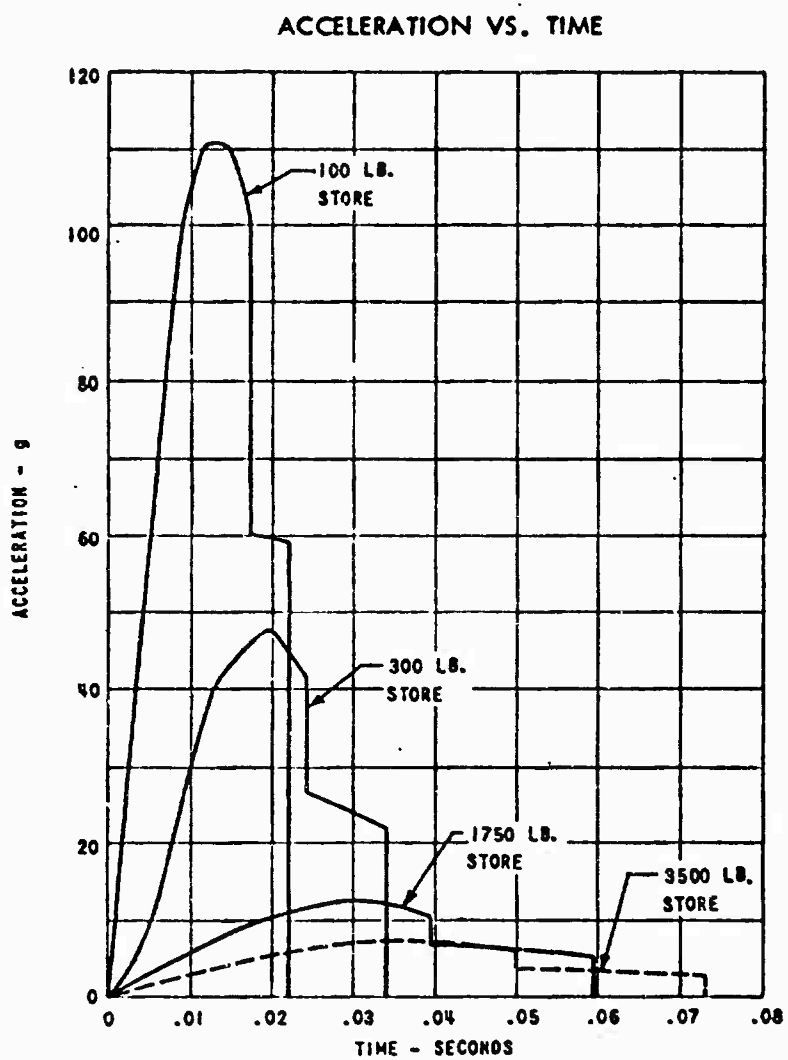
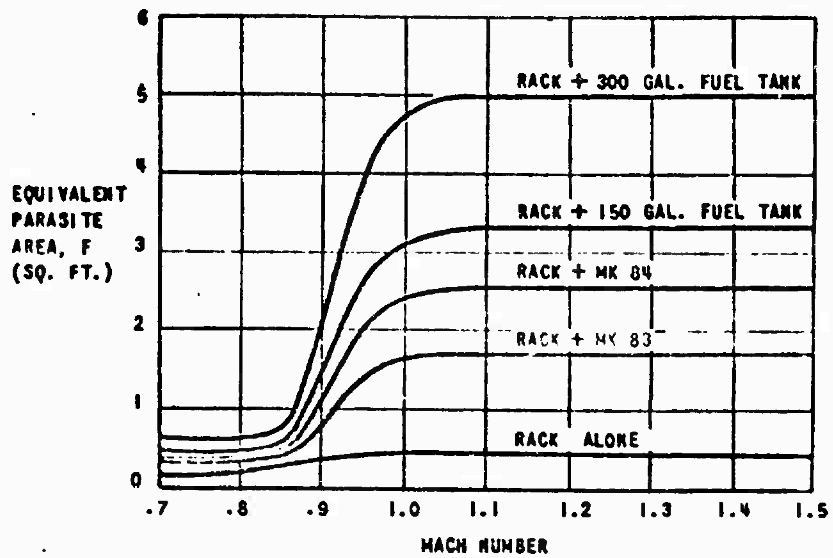


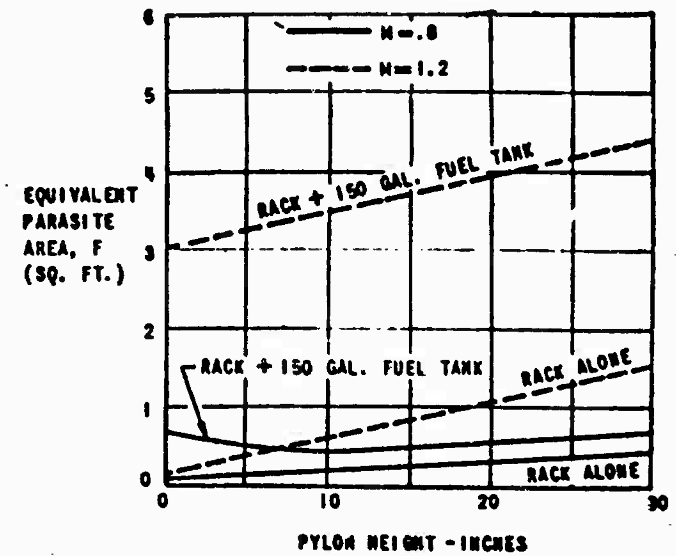
CHART BASED ON ONE MK.2 MOD.0 AND ONE MK.1 MOD.2 CARTRIDGE.

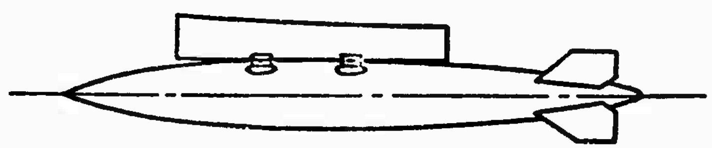
AERODYNAMIC CHARACTERISTICS

DRAG RISE OF TYPICAL STORE INSTALLATIONS



EFFECT OF PYLON HEIGHT ON DRAG OF TYPICAL STORE INSTALLATION





N.TE: DATA BASED ON RACK HOUSED IN TYPICAL PYLON FA' 'NG.

VERT LOAD AT ? SIDE LOAD DERIVED FROM MIL-R-22622
RACK OUTLOAD TEST CONDITIONS.
71,000# - 30" HOOKS   65,000# - 14" HOOKS.

STRENGTH CHARACTERISTICS

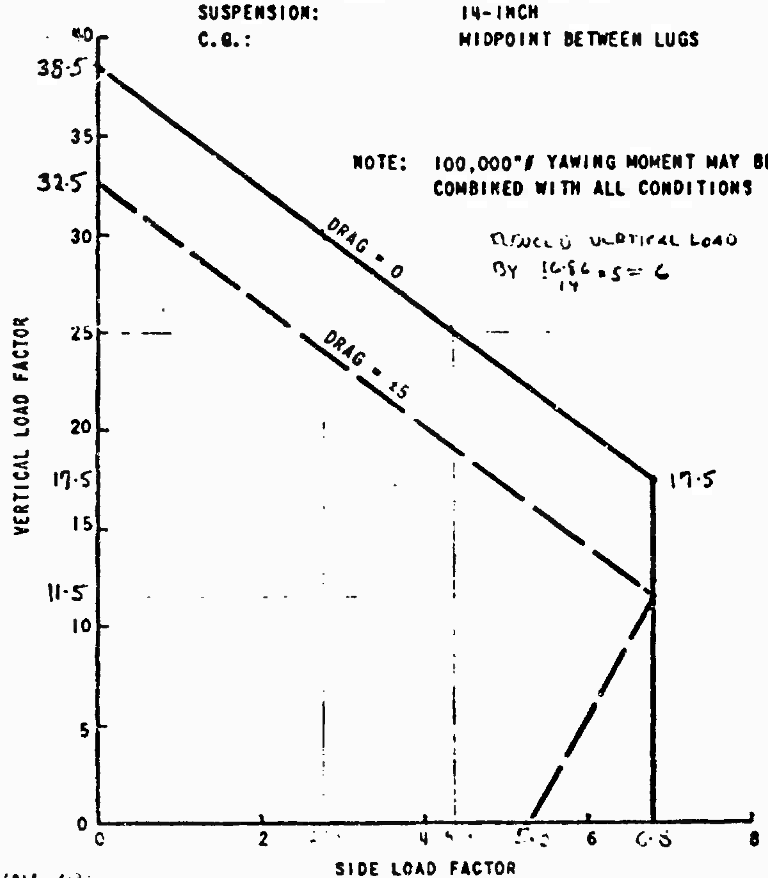
32,500# PER HOOK

ULTIMATE STRENGTH ENVELOPES

STORE:	T63
WEIGHT:	1700 LBS.
DIAMETER:	30.5 INCHES
MOMENT OF INERTIA:	1,800,000 (LB. IN.)^2
SUSPENSION:	14-INCH
C.G.:	MIDPOINT BETWEEN LUGS

NOTE: 100,000"# YAWING MOMENT MAY BE COMBINED WITH ALL CONDITIONS

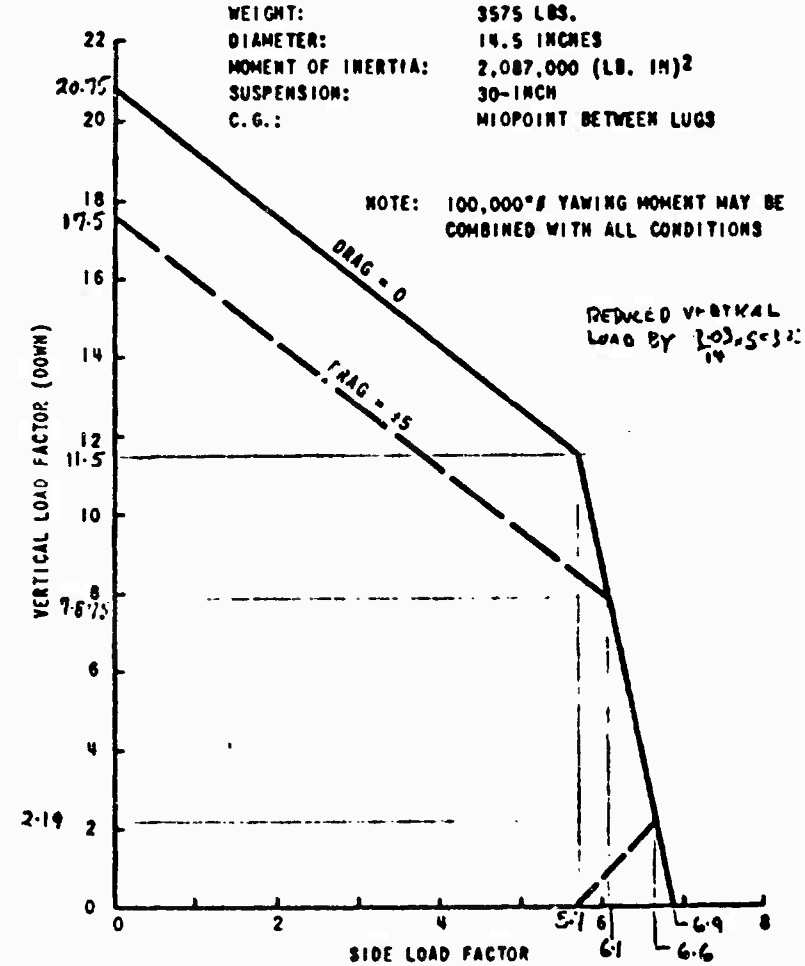
REDUCED VERTICAL LOAD BY $\frac{16.56}{14} \times 5 = 6$



STORE:	T65
WEIGHT:	3575 LBS.
DIAMETER:	14.5 INCHES
MOMENT OF INERTIA:	2,087,000 (LB. IN)^2
SUSPENSION:	30-INCH
C.G.:	MIDPOINT BETWEEN LUGS

NOTE: 100,000"# YAWING MOMENT MAY BE COMBINED WITH ALL CONDITIONS

REDUCED VERTICAL LOAD BY $\frac{?}{14} \times 5 = 3.?$



NAVY ? ... VERT LOAD DERIVED ... AERO 7A EJECTOR RACK

APPENDIX C

SUSPENSION SYSTEM BOLT REACTIONS

APPENDIX C

I. INTRODUCTION

This Appendix presents results of analysis of bolt reactions at the A-4 centerline fuselage surface due to the worst case store loadings obtained from Appendix A. The program utilized for this purpose was developed as a tool for the design of a hard-mount pylon for the RMK-19/A47U-3 real-launcher by Carl Reitz. A copy of the author's comments regarding the analytical technique is provided on page C-9.

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II ANALYSIS OF BOLT/STUD REACTIONS

A DEFINITIONS & ASSUMPTIONS

1. DEFINITIONS

SEE FIGURE C-1

SIGN CONVENTION PER MIL-A-8591

D = REACTION TO DRAG LOAD

S = REACTION TO SIDE LOAD

V = REACTION TO VERTICAL LOAD

Q = TOTAL SHEAR LOAD

2. SYMMETRY ASSUMPTIONS

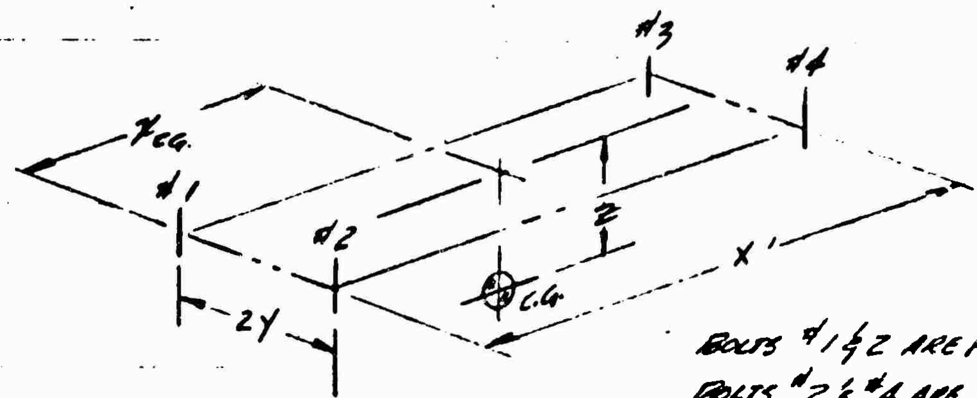
① $D_f = D_f' = D_a = D_a'$

② $S_f = S_f'$; $S_a = S_a'$

③ $$V_i^j = (-1)^{i+1}\frac{z}{2X}P_x + (-1)^j\frac{z}{4Y}P_y + \left[(-1)^i\left(\frac{1}{4} - \frac{x_{cg}}{2X}\right) - \frac{1}{4}\right]P_z + (-1)^j\frac{M_x}{4Y} + (-1)^i\frac{M_y}{4X}$$

WHERE: $i = 1 \Rightarrow V_f$ $\quad j = 0 \Rightarrow V$

$i = 2 \Rightarrow V_a$ $\quad j = 1 \Rightarrow V'$



BOLTS #1 & 2 ARE FWD

BOLTS #2 & #4 ARE PRIME

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B ANALYSIS DATA & RESULTS

1. LOADS - SEE TABLE C-I

2. REACTIONS - SEE PAGE C-10

C. MS 20012-34 BOLT STRENGTH (MIL-B-7838)

ULTIMATE TENSILE STRENGTH = 63,200

ULTIMATE DOUBLE SHEAR STRENGTH = 83900

FATIGUE LOADING - LOW TENSION LOAD = 2920

FATIGUE LOADING - HIGH TENSION LOAD = 29200

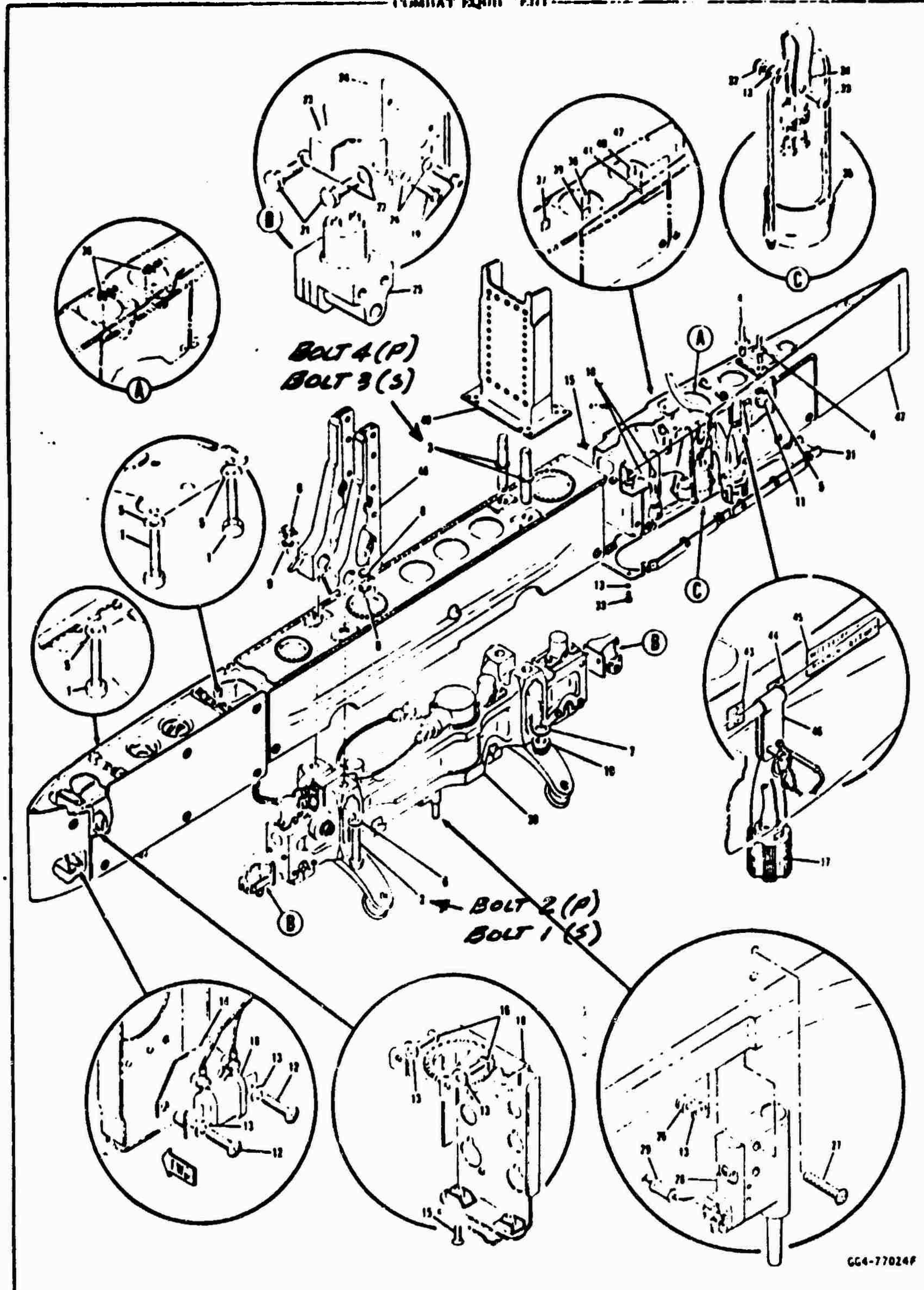

Figure 23 – Fuselage Bomb Ejector Rack

FIGURE C-1

DATA SHEET
4ND-NADC-3960/11

TABLE C-I

SUMMARY OF WORST CASE SUSPENSION LOADS

LOADING CONDITIONS								FORCES & MOMENTS AT C.G.					
CASE	COND.	X_{CG}	W	I_{XX}/g	I_{YY}/g	I_{ZZ}/g	LOAD	P_X	P_Y	P_Z	M_X	M_Y	M_Z
	FERRY	65.3	1569	—	3080	3064	AIR	404	-517	-389	0	-19532	-25822
	FERRY						INERTIA	2354	-1099	-13651		-12318	-6128
1	FERRY						TOTAL	2758	-1616	-14040		-31850	-31950
	ARREST						AIR	0	0	0		0	0
	ARREST						INERTIA	-12552	-785	3138		18477	9192
2	ARREST	65.3	1569		3080	3064	TOTAL	-12552	-785	3138	0	18477	9192
	TOW	64.6	1439		3012	2996	AIR	4329	-477	-463	209	-13165	-17222
	TOW	64.6	1439		3012	2996	INERTIA	2159	-1008	-4317	0	-12045	-5992
3	TOW	64.6	1439		3012	2996	TOTAL	6488	-1485	-4780	209	-27210	-23214
	TOW FAIL	62.7	1179		2813	2797	AIR	6006	610	716	-2563	76255	-48556
	TOW FAIL	62.7	1179		2813	2797	INERTIA	1769	-826	-2358	0	-11250	-5594
4	TOW FAIL	62.7	1179	—	2813	2797	TOTAL	7775	-216	-1642	-2563	-87505	-54150

PLATE NO. 13038

13 June 1974

C. O. [illegible]

[illegible]
VIA: [illegible]

Tow Reel Mounting Reactions; solution of

1. A FORTRAN computer program has been coded to compute the reactive forces associated with an airborne store suspended from four (4) bolts. The program is intended to provide design data for the tow reel to aircraft mount being developed under [illegible] (Naval Standard Tow Target System). Approximately forty ([illegible]) man-hours have been expended generating the subject program.

2. The reel to aircraft mount represents a statically indeterminant structure. Symmetry assumptions with respect to the bolt reactions permitted a statically determinant solution which is sufficient for preliminary design. An indeterminant analysis of the structure may be required after the configuration of the mount is known.

3. A memorandum describing the derivation and use of the subject program will be generated as time permits.

C. O. [illegible]

Copy to:
[illegible]
[illegible] (RC)
C. [illegible]/[illegible]/6-13-74/[illegible]

FOUR BOLT REACTIONS FOR SUSPENDED LOADS
(STATICALLY DETERMINANT SUBJECT TO SYMMETRY ASSUMPTIONS)

LOAD CASE	P(X) LB	P(Y) LB	P(Z) LB	M(X) IN-LB	M(Y) IN-LB	M(Z) IN-LB
1	2758.0	-1616.0	-14040.0	0.0	-31850.0	-31950.0
2	-12552.0	-785.0	5133.0	0.0	18477.0	-9192.0
3	6488.6	-1455.0	-4783.0	209.0	-27218.0	-23214.0
4	7775.0	-216.0	-1042.0	-2563.0	-87505.0	-54150.0

BOLTS LOCATED AT STORE STATIONS 70.500 AND 90.500
BOLTS ARE 1.508 INCHES FROM FORE-AFT CENTER LINE
CG OF STORE IS 21.980 INCHES BELOW BOLT PLANE

CENTER OR GRAVITY OF STORE IS AT STATION 55.330, XCG = -5.500
BOLT 1 ... FWD,RIGHT BOLT 2 ... FWD,LEFT
BOLT 3 ... AFT,RIGHT BOLT 4 ... AFT,LEFT

LOAD CASE	BOLT	D - LB	S - LB	V - LB	D - LB
1	1	-683.	1823.	5333.	1955.
1	2	-689.	1823.	17155.	1955.
1	3	-689.	-1021.	-10135.	1232.
1	4	-683.	-1021.	1552.	1232.
2	1	3138.	736.	-12203.	3222.
2	2	3138.	736.	-5453.	3222.
2	3	3133.	-336.	4906.	3156.
2	4	3138.	-336.	10631.	3156.

CENTER OR GRAVITY OF STORE IS AT STATION 54.530, XCG = -6.200
BOLT 1 ... FWD,RIGHT BOLT 2 ... FWD,LEFT
BOLT 3 ... AFT,RIGHT BOLT 4 ... AFT,LEFT

LOAD CASE	BOLT	D - LB	S - LB	V - LB	D - LB
3	1	-1622.	1553.	1378.	2246.
3	2	-1622.	1553.	12749.	2246.
3	3	-1622.	-811.	-10359.	1613.
3	4	-1622.	-811.	412.	1613.

CENTER OR GRAVITY OF STORE IS AT STATION 52.710, XCG = -8.100
BOLT 1 ... FWD,RIGHT BOLT 2 ... FWD,LEFT
BOLT 3 ... AFT,RIGHT BOLT 4 ... AFT,LEFT

LOAD CASE	BOLT	D - LB	S - LB	V - LB	D - LB
4	1	-1944.	1505.	5382.	2459.
4	2	-1944.	1505.	881.	2459.
4	3	-1944.	-1597.	-7333.	2394.
4	4	-1944.	-1597.	-5351.	2394.

APPENDIX D

TOW TARGET SYSTEM FLIGHT TEST

INSTALLATION CHECK & TEST REQUIREMENTS
OPERATING LIMITATIONS
FLIGHT LIMITATIONS
AIRSPEED & ALTITUDE RESTRICTIONS

APPENDIX D

This Appendix provides aeromechanical data required to operate the tow target system on the A-4 airplane. The data provided herein is proposed for flight test purposes.

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TOW TARGET SYSTEM FLIGHT TEST

TEST NO. VC-2

FLIGHT TEST DATE		TIME	
TEST A/C TYPE	TA4J	NO	154327
CHASE A/C TYPE		NO	
TEST A/C PILOT			
RIO			
CHASE A/C PILOT			
BASE COMMUNICATIONS			
FIELD COMMUNICATIONS			

RADIO FREQUENCIES

T.O. TIME

LAND TIME

NOTES

INSTALLATION CHECK & TEST REQUIREMENTS

TEST NO. VC-2

MAX. IN ANGLE, DEGREES	45	+ 0	- 2
MIN IN ANGLE, DEGREES	5	+ 0	- 2
MAX OUT ANGLE, DEGREES	45	+ 0	- 2
MIN OUT ANGLE, DEGREES	0	+ 1	- 1

TARGET PRELOAD, POUNDS to

AIR PRESSURE, PSI 2000 MINIMUM

TOW TARGET SYSTEM CONFIGURATION

TARGET, S/N DESIG.		FIGAT
TOWLINE, S/N DESIG.		0.182 3X7 ALTERNATE 11/64 ARMOR
REEL-LINE, S/N DESIG.	022	KMU-8/A 30IN-DIA PWR UNIT SEMI-AUTO CONTROL
CONTROL, S/N DESIG.	DVS-0003	PEK-84 MODIFIED FOR SEMI-AUTO CONTROL

NOTE - TENSION METER ON PEK-84 READS ONE HALF ACTUAL TENSION

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OPERATING LIMITATIONS

TEST NO. VC-2

MAX. TOWLINE LENGTH, FT.		SEE NOTE 1.	
MAX. TENSION POUNDS	STOWED		
	TOWING	NOTE 2.	
REELING RATE FT/MIN.	LAUNCH		MAX.
	OUT	2300	MAX.
	IN	2000	MAX.
	FINAL RECOVERY	500 TO 100 (NOTE 3.)	
BEGIN FINAL RECOVERY, FT.		500	MIN.

CAUTION

BOTH IN ANGLE AND OUT ANGLE LIGHTS MUST BE OUT, WITHOUT TARGET, TARGET STOWED OR TOWING, WITH BRAKE ON TO PREVENT OVERLOAD OF POWER UNIT DRIVE SHAFT.

NOTES

1. TO BE FILLED IN PRIOR TO EACH FLIGHT
   MAX TOWLINE LENGTH = LENGTH ON SPOOL MINUS 500 FEET
2. MAX. TENSION 0.182 3X7 = 4000
   11/64 ARMOR = 2800
3. SCHEDULE 500 AT 500 FEET STREAMED DOWN TO 100 AT LESS THAN 200 FEET STREAMED

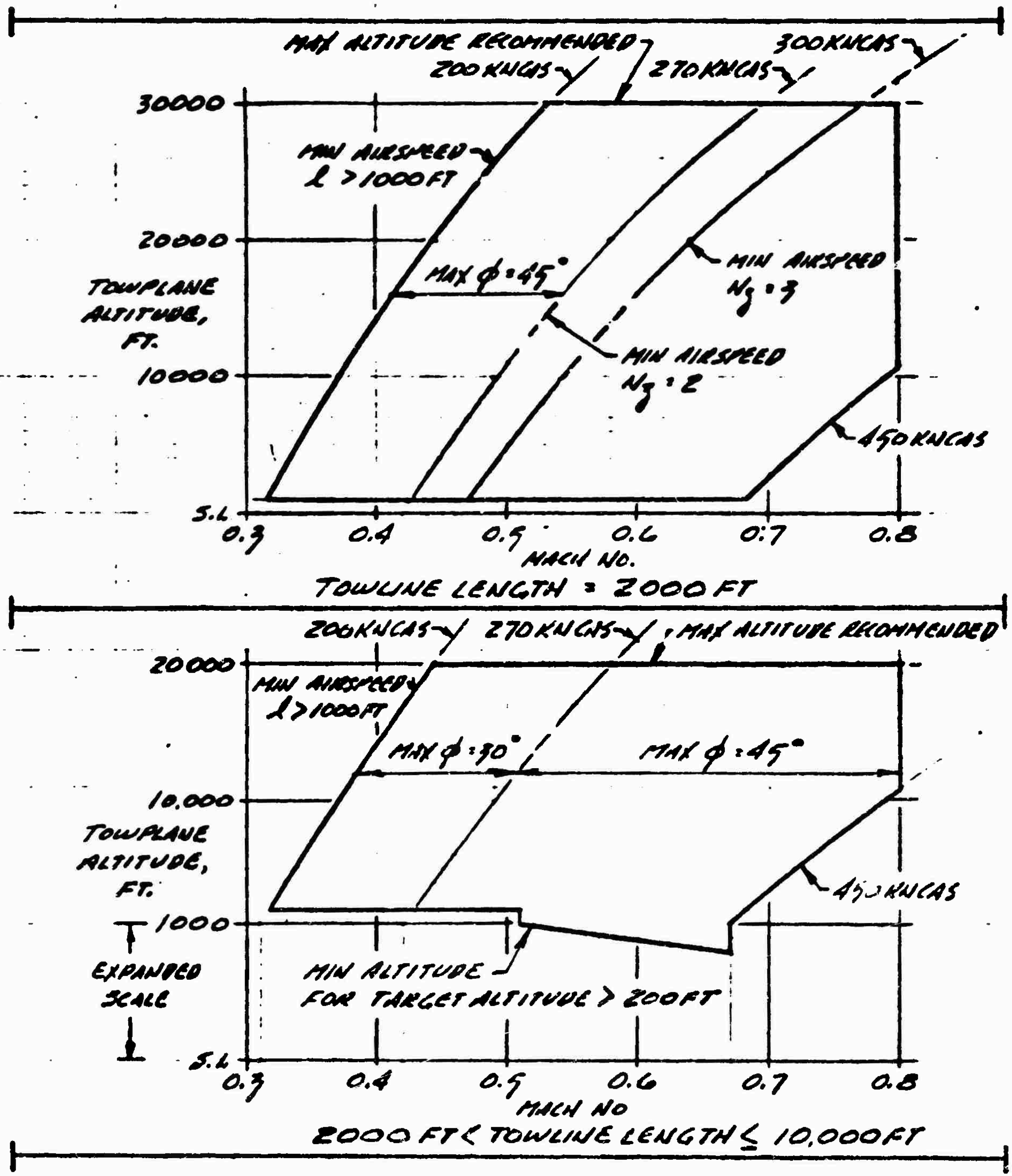
FLIGHT LIMITATIONS - TO BE REVISED FOR NATC FLIGHT TEST

TEST NO. VC-2

WITHOUT TARGET, TOWING LIMITS APPLY

MAX. AIRSPEED KN, CAS	STOWED	300	(SHORT TOW)
	LAUNCH		
	LOCK ON		
	REEL-OUT	300	
	TOWING	450	
	REEL-IN	300	
	FINAL RECOVERY	300	
MAX. MACH NUMBER	STOWED	0.8	
	REELING	0.8	
	TOWING	0.8	
MAX. ALTITUDE FEET	LAUNCH	AS REQ'D	
	RECOVERY	AS REQ'D	
MAX. BANK ANGLE DEGREES	STOWED	60	(SHORT TOW)
	LAUNCH & RECOVERY	30	
	REELING	30	
	TOWING	70	$(1 < N_Z < 3)$ *

* SUBJECT TO MIN AIRSPEED RESTRICTION AS ATTACHED. WITHOUT TARGET, $0 < N_Z < 4$ ABRUPT CONTROL DEFLECTION & YAW PROHIBITED



AIRSPEED & ALTITUDE RESTRICTIONS FOR MANEUVERING FLIGHT-TOWING PROFILE FIGHTER (FIGAT) TARGET